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Citrus Preservation Committee—Progress Report (October, 1932.)

In the *Journal of the Council for Scientific and Industrial Research* (1: 307, 1928,) an account was given of the formation of the Citrus Preservation Committee, and of its objects. The necessity at the time for the research work then proposed was summarized in general terms in the opening paragraph as follows:—

> "For some time past, those connected with production of citrus fruit in Australia have felt that the industry could be expanded considerably if a means could be discovered whereby the fruit could be made available the whole year round, and whereby its condition could be maintained for a sufficiently long period to render its export to other countries possible."

As previously stated, the Committee is representative of the following organizations:—

The Council for Scientific and Industrial Research;

The Victorian Department of Agriculture;

The Victorian Central Citrus Association;

The Victorian Railways.

A full account of the technique adopted was published in 1930 (this *Journal* **3**: 69, 1930), and progress reports have been issued from time to time on the various aspects of the work (this *Journal* **4**: 96, 1931. *Jour. Dept. Agr. Vict.* **29**: 590, 1931).

One of the main investigations has been the study of the effects of treatment of oranges with preservative solutions, notably borax (5 per cent.), and sodium bicarbonate (2.5 per cent. and 5 per cent.)., and the subsequent coating of the fruit with a film of paraffin wax. Other solutions have also been employed, including sodium sulphite, salicylic acid, and benzoic acid, but as these have had no definite effect, it is not considered necessary to discuss the results obtained by their use.

The experiments have now extended over four years, in each of which both Navel and Valencia oranges have been treated; and it is considered that a stage has been reached at which it is possible to come to a decision as to the benefits to be derived from such treatment.

Whilst in the first two years these tests were carried out with fruit from the Mildura district, oranges from other irrigation areas, such as Berri, Murrabit, Perricoota, Lake Kangaroo, and the Murrumbidgee

area, have been studied during the last two seasons, but no striking differences have been disclosed in the storage properties of fruit from these different districts.

The main object of the present communication is to give the general conclusions reached by the Committee as the result of this work, principally for the benefit of those sheds which may be contemplating the installation of washing and spraying plants.

Handling and Packing.

The experiments have confirmed the opinion that the advantages to be gained by handling all fruit carefully are considerable. Particular attention to shed hygiene, such as keeping all machinery with which the oranges may come in contact clean, and keeping the sheds free from dirt and old decaying fruit, is also strongly advocated. Packing too tightly is a consistent cause of damage to oranges, and in particular high packing and the consequent excessive bulge, with its unavoidable injury during lidding, are strongly deprecated.

Unpacked, loosely-filled cases of fruit show better keeping qualities in cold store than fruit wrapped and packed prior to storage.

In the experiments with Navel oranges, no advantage has been gained by the use of grease-proof or waxed papers in place of the cheaper and more easily handled sulphite tissue.

Washing.

Washing with 5 per cent. borax solutions or with either 2.5 per cent. or 5 per cent. sodium carbonate solutions has not shown, over the four seasons, that it definitely prolongs the life of Navel oranges in cool storage.

In almost all the experiments conducted by the Committee, the fruit was packed loosely into cases and railed to Melbourne, where it was treated and then packed in the commercial way. Under such conditions, the incidence of blue and green moulds, during the period that the fruit remains otherwise sound and palatable, was so small, even in the untreated controls, that no opportunity for material reduction in wastage from this cause has been offered.

In a number of cases, the incidence of mould has been reduced by the solutions at a late stage in the storage life of the fruit; but only at times when the fruit, due to the length of the storage period, had begun to collapse, lose its flavour, and become presumably more susceptible to mould attack. As the fruit at such times had no commercial value, because of its unpalatability, the protection from moulds was valueless. The solutions have no preservative effect, apart from their suggested influence, on mould attack.

With Valencia oranges, washing with borax had a definite effect in reducing the incidence of *Alternaria* (stem end rot), the chief cause of wastage after two or three months' storage. Sodium bicarbonate, on the other hand, has shown no consistent result in this direction. For Valencias, therefore, borax is to be preferred to sodium bicarbonate.

The washing treatment certainly improved the appearance of the fruit, especially when it was dirty; but it is improbable that the installation of washing apparatus could be justified on this ground, except when a large percentage of the fruit of a district was dirty.

Spraying with Paraffin.

With Navel oranges, no advantages have been observed—other than an improved appearance—when the fruit has been coated with paraffin wax subsequent to the washing treatment. When applied very lightly, no deleterious effect was observed, but heavier sprays actually shortened the life of the fruit. There is, therefore, a definite danger in the use of paraffin.

With Valencia oranges, no premature collapse of the fruit has been induced in any of the experiments by the paraffin spray. On the contrary, paraffin has usually lowered the amount of skin browning of Valencias, and further experiments upon this aspect are contemplated. Spraying with paraffin had almost as beneficial an effect in reducing stem end rot as had borax, the most effective treatment being a combination of washing with borax and spraying with paraffin subsequently.

As, however, the experimental Valencias when carefully handled were kept in good commercial condition without treatment for three months, and it was only at this stage that wastage due to *Alternaria* began to appear, the advantages of the treatment from a preservative point of view were confined to fruit stored for periods longer than, say, three months. It does not appear likely that, in practice, any considerable percentage of the Valencia crop of any district will be cool-stored for periods longer than this; and it is therefore improbable that the advantages to be gained justify the installation of the necessary apparatus.

Dirty oranges, however, both Navel and Valencia, are considerably improved in appearance by the treatment.

Temperature of Storage.

Taken over the four years, 38° Fahr. has been found to be the most satisfactory temperature for storage for both Navel and Valencia oranges. There have been indications, however, that storage at 45° Fahr. under conditions not yet determined may be superior for Navels, and experiments are in progress at the present time upon these conditions. Temperatures below 38° Fahr. appear to be quite undesirable.

Sweating.

From the limited experiments hitherto conducted by the Committee upon the "sweating" of oranges prior to packing, no definite results have been obtained. Work by Tindale and Fish of the Victorian Department of Agriculture, however (*Jour. Dept Agric. Vict.* **29**: 101, 1931), has shown the possibilities of sweating at high temperatures in controlled atmospheres; and the Committee, having erected a special chamber in which temperature and humidity can be controlled, is collaborating with these workers. Experiments are at present in progress.

Commercial Storage Life.

The Committee would not advise the cool storage of Navel oranges for periods longer than five weeks. After this length of time, a very marked deterioration of the appearance of the rind, and of the flavour

of the juice—usually referred to by the Committee as "collapse"—is liable to occur quite suddenly, and cause very serious loss. It is true that odd lots of Navels of exceptional keeping quality have been known to last in cool store for much longer periods than five weeks; but it is not considered that these are in any way typical of the bulk of our Navel crop.

From the export point of view, we would appear to be limited to ports not more than three weeks' steaming distance away. Under present conditions, export further afield would appear to be distinctly hazardous.

The Valencia orange has a much longer life in cool store than the Navel. With reasonable care, it can be kept approximately three months in store without prohibitive loss; and the onset of wastage is not sudden but rather progressive.

The export of Valencia oranges, should it become necessary, would present no serious difficulty.

Variations in Keeping Quality due to Season and District.

Although no precise data on this aspect have been secured, it is possible, as the result of the four years' experience, to come to the general conclusion that keeping quality does vary somewhat from year to year, and that the most important factor appears to be the rainfall in autumn and winter. 1929, a dry year, was a good keeping year; 1931, a very wet year, was a very poor one—from the trade's point of view it was frequently disastrous.

No marked differences between the storage properties of fruit from the various districts studied have been disclosed. This is perhaps to be expected, since they are all irrigated areas with a rather limited rainfall, viz., Mildura (including Merbein and Irymple), Curlwaa, Berri, Lake Kangaroo, Murrabit, Perricoota and Griffith. Nevertheless, the soil types vary widely from the very light red soils, such as Mildura and Perricoota, to the very heavy black soil of Murrabit. Climate is apparently more important than soil type. Thus, in experiments conducted by the New South Wales Department of Agriculture on fruit from the high rainfall, non-irrigated citrus areas north of Sydney, wastage—especially the loss from mould attack—is shown to be very much higher than has been experienced in the irrigated, dry-climate fruit studied by the Committee.

It is interesting to note that washing with borax in New South Wales has been found to reduce significantly mould infection on this apparently rather susceptible fruit. The type of fruit used by this Committee, on the other hand, appears to possess, when handled carefully, a much higher natural resistance to mould attack. Under such conditions, practically no further improvement can be brought about by the use of borax.

Fly Strike of Sheep: A Natural Phenomenon.

*By F. G. Holdaway, M.Sc., Ph.D.**

At the present time, there is in the press a comprehensive report dealing with all aspects of the blowfly problem in Australia. The report itself has been prepared under the aegis of the Joint Blowfly Committee of the Council and of the N.S.W. Department of Agriculture. It discusses all aspects of the problem such as biological control, dipping, swabbing, jetting, trapping, breeding for resistance, &c., and will be issued as soon as possible (at a price of about 1s. 6d. per copy) as a joint publication of the two above-mentioned bodies. In the meantime the Joint Blowfly Committee has recommended that the following article by Dr. Holdaway dealing with one aspect of the blowfly problem be published.—[Ed.]

Summary.

The theories which have been advanced in connexion with the fly problem in Australia are summarized and discussed briefly. A distinction is drawn between theories on what strike is and theories on the development of the fly problem in Australia.

Evidence regarding the attraction of blowflies, the oviposition responses of the female flies, the development of the larvae, and the succession of flies in carcasses and on living sheep is cited in support of the contention that bacterial activity in wool is a forerunner to strike in much the same way as bacterial activity on the skin and in the hair of dead mammals is a forerunner to attraction of flies and development of larvae thereon.

This contention is supported by our observations on strike in the field and by the experiments of C. R. Mulhearn and M. J. Mackerras. Johnston's theory that strike is associated with bacterial activity in the wool is thus considered to be proved, and Froggatt's theory that blowflies had changed their habits is considered unnecessary.

A study of conditions in the wool which favour or inhibit bacterial activity thus becomes an important aspect of the study of the blowfly problem.

1. Introduction.

When in Europe from 1928 to 1930, the writer made a general study of the facts available concerning the sheep blowfly problem. It was hoped thereby to open up additional lines of investigation which might prove of value in Australia. As a result of this study, the conclusion was reached that a satisfactory understanding of fly-strike in sheep was intimately connected with a knowledge of conditions favouring bacterial growth in the fleece.

In May, 1931, after the writer's return, an excellent opportunity for studying strike arose in the Riverina districts of New South Wales. The observations, made with Mr. C. R. Mulhearn, were concerned especially with "body strike," or fly attack on the body in places other than the breech, prepuce, and head. They were made concurrently with, though quite independently of, observations made by Dr. H. R. Seddon and his co-workers, and have given an opportunity for resuming the studies begun in Great Britain and for utilizing the information secured there. Further, they have shown that the conclusion reached earlier regarding the association of fly strike with bacterial activity in the wool was justified, and they have demonstrated in a striking way the importance of the bacteriology and the bio-chemistry of the fleece in relation to the fly problem.

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During the early stages of the inquiries in Great Britain, I had the benefit of the advice of several workers, of whom I wish to mention, especially Dr. W. R. Thompson, Imperial Institute of Entomology, Farnham Royal; Dr. J. W. Munro, Imperial College of Science, London; Dr. Golding, Imperial Institute, London; Dr. S. G. Barker and staff, British Wool Industries Research Association, "Torridon," Headingley-lane, Leeds; and Dr. J. B. Orr, Rowett Institute, Aberdeen. In preparing the present paper and those which may follow, benefit has been derived from discussions with members of the Joint Blowfly Committee and my colleagues in the Blowfly Section of the Division of Economic Entomology. I am also indebted to members of the staff, particularly Mr. C. R. Mulhearn, Dr. M. J. Mackerras, and Miss Mary Fuller, for making available results of unpublished work. Observations on sheep in the field were possible through facilities readily provided by a number of pastoralists; their assistance is gratefully acknowledged.

2. Theories of Blowfly Strike.

Several explanations have been advanced to account for the development of the sheep blowfly problem in Australia. They are:—

1. Froggatt's theory of the change in habit of the native blowflies (13) 1904, (14) 1915. This theory was accepted in a slightly modified form by the New South Wales External Parasites of Sheep Committee (8) 1928.
2. Johnston's contention that gravid female blowflies were attracted to sheep and induced to oviposit on them as a result of bacterial activity in the soiled wool (19) 1923.
3. The contention advanced by Mackerras that the spread of the problem followed the spread of the European fly, *Lucilia sericata* Meig. (1) 1930. This theory has been adopted recently by Roberts (23) 1931.
4. The contention of Seddon, Belschner, and Mulhearn that fly attack became serious following the introduction of the wrinkly Vermont sheep (25) 1931.

In order to explain the development of the fly problem in Australia, it is necessary to understand (i) what fly-strike is, and (ii) how and why fly-strike developed in Australia.

Froggatt's theory was an attempt to explain both these phenomena. Johnston attempted to explain what fly-strike was. Mackerras, and Seddon, Belschner, and Mulhearn, were concerned with the development of the problem in Australia and not with the explanation of fly-strike in general.

In the present article, information available is used to answer the first of the questions given above, i.e., to explain what is involved in fly attack of sheep. It will be shown that Johnston's suggestion is sound, and Froggatt's assumption that the flies had changed their habits is unnecessary. In another article it is proposed to consider the theories of strike in greater detail, and to advance a new hypothesis on the origin of fly attack in Australia.

3. Oviposition by Blowflies on Dead Mammals.

Adhesion to the theory suggested by Froggatt that the flies had changed their habits* from ovipositing in carrion to ovipositing in the wool of living sheep is still fairly widespread and has found its way into the literature of other countries (22). It is perhaps natural that, in the absence of evidence to the contrary, such a theory should have been retained, for until Seddon's (26) recent publication describing fly attack on "water rot" of wool, Johnston's paper is the only publication which would be likely to dispel the idea.

The picture created by the word carrion is that of a mass of putrefying animal matter. As regards the main portion of the larval life of blowflies, such a conception is correct. But oviposition and early larval life occur in animals recently dead (Holdaway (17)). Further, although in dead mammals oviposition takes place in the moist openings of the body—the eyes, nose, mouth, and anus—a considerable amount of oviposition takes place also in the hair (Foreman and Graham-Smith (10)).

Experiments on rabbit carcasses which the writer made in France showed that oviposition by the European sheep blowflies, *Lucilia sericata* and *Calliphora erythrocephala,* is mainly in the fur. The rabbits were killed so that no blood was spilt, and the bodies were laid on the surface of the ground. Oviposition occurred, especially in the fur which was moist through contact with the ground, and the young blowfly larvae passed their early life, at least up to the beginning of the second instar, on the surface of the skin. Observations which the writer has made recently on dead sheep also show that, during the first few days after death, there is a considerable amount of oviposition in the wool.

Without considering for the moment the physiology of oviposition and larval nutrition, the fact that, in carcasses of mammals, oviposition occurs in the hair (or wool) and early larval development takes place in the hair and on the skin, while in strike oviposition is in the fleece and larval development takes place in the fleece and on the skin, suggests that fly strike in sheep is a natural phenomenon comparable to fly development on the carcasses of mammals.

4. Attraction and Oviposition of Blowflies.

Observations and experiments by many workers have demonstrated that the odours which attract adult saprophagous flies, particularly the gravid females, are products of fermentation or putrefaction. It is still unknown whether, for any species of fly, the attraction is the result of a specific odour or a combination of odours, but it is known that the activity of certain micro-organisms is responsible for the production of substances which attract the flies. The experiments of Foreman and Graham-Smith showed that prevention of such microbial activity on dead bodies by sterilization resulted in blowflies not being attracted to the bodies. It was not merely that blowflies were repelled by the creosote used, as carcasses treated with creosote all over, with the deliberate exception of small areas, had eggs laid on the untreated portions.

In general, oviposition by blowflies takes place on a medium suitable for the development of the larvae. However, it has been shown experimentally by Cousin (4), (5), (6), with *Lucilia sericata* Meig., and by

* Although Froggatt used the words "changed their habits," what he undoubtedly meant was that they had taken on a new habit in addition to those which they already possessed.

M. J. Mackerras with *L. sericata* and *Achaetandrus rufifacies* Macq.* that blowflies will lay their eggs on any medium which can provide the stimuli necessary for the oviposition reflex regardless of whether the medium is suitable for larval development or not. For example, flies sometimes lay their eggs on fruits, blankets, saddle cloths, and non-susceptible sheep on which the larvae cannot develop. When, therefore, blowfly larvae develop in nature, we have an association of two distinct phenomena, namely, (i) suitability of the medium for stimulating oviposition, and (ii) suitability of the medium for development of the larvae. This distinction is fundamental in the study of susceptibility to strike, for it indicates the necessity for determining not merely whether the sheep are attractive to the fly but more particularly whether conditions in the wool are suitable for larval development.

5. The Normal Development of Blowfly Larvae.

Soon after the death of an animal, the epidermis desquamates. Further, in the early stages of putrefaction there is pronounced bacterial activity on the skin. The larvae which developed from eggs laid on the rabbits mentioned above, passed the early portion of their lives feeding on the surface of the skin.

The larvae of saprophagous insects live in general in association with micro-organisms which partially digest their food (3), (15), (20), (28). However, cases of successful attempts to rear normal saprophagous larvae on a sterile medium are on record (2), (16), (30), (31). Frew (11), who also succeeded in rearing blowfly larvae aseptically, considered that their growth was not quite normal. Uvarov (28) sums up the evidence as follows:—"The absolute necessity of bacteria for the nutrition of the larvae is, therefore, doubtful, but this hardly affects the fact that normally the larvae develop on a substratum already liquefied by bacteria." Further, Hobson (15) says with regard to *Lucilia sericata*:—"Under favourable conditions the activities of bacteria will supply the larvae with partly-digested food. . . . In the absence of liquid food, the cells (of the mid-gut) will become free from fat and secrete more actively thus securing an increased liquefaction of the meat since a part of the tryptase is excreted."

One can state then that normally the nutrition of the larvae of primary blowflies, i.e., those early in the ecological succession in carcasses (17) and which initiate strike, is associated with bacterial activity; the bacteria are present on the skin and, provided there is adequate moisture, dead cells and other organic material form a suitable medium for their multiplication.

6. Succession of Insect Inhabitants in Dead Bodies and on Living Sheep.

A definite succession of insect visitors and insect inhabitants of putrefying animal matter has been recorded by several workers (21), (9), (17), and has been studied in detail by the writer in Europe and by Miss Mary Fuller in Australia.

This succession is no doubt intimately related to a succession of bacterial flora such as has been recorded by Effront and Prescott (7). Of particular interest to a study of the blowfly problem, is the fact that flies of the species which initiate strike are among the earliest visitors

* This species has had several names, but has been known especially as *Chrysomyia albiceps* and *A. rufifacies*. (18.)

to dead bodies and oviposit there soon after death, whilst flies such as *Achaetandrus rufifacies* Macq. *Microcalliphora varipes* Macq., *Chrysomyia micropogon* Bigot, and *Peronia rostrata* R.D. appear later. The evidence to date, which has been collected by various members of the Blowfly Section and in particular by Dr. I. M. Mackerras, indicates that the production of strike by flies belonging to these four species usually, if not always, follows attack by a primary fly which is an early member of the succession in carcasses.

These facts suggest further that in fly-strike of sheep we have a phenomenon very similar to that associated with oviposition and larval development on dead bodies.

7. Bacterial Activity Associated with Fly Strike in Sheep.

If it be accepted then that bacterial activity is associated with the attraction of the female flies to places where they oviposit, with the provision of the stimuli necessary for the oviposition reflex and with the development of blowfly larvae in carcasses, and that if further there is a succession of fly visitors to the wool of living sheep similar to that occurring in dead animals, it would be logical to expect that fly-strike of sheep was also associated with bacterial activity. That this is so is now a demonstrated fact.

For bacterial activity, the two most important requirements are adequate moisture and a suitable nutrient medium. During the autumn of 1931, we had, in "body strike," an excellent example supporting the general thesis that bacterial activity in wool is a forerunner of strike. In these cases, it was possible to study strike under conditions devoid of the complicating features found in crutch-, prepuce-, or head-strikes. Moisture was contributed by continuous rains and the bacterial conditions which preceded strike were those referred to collectively as "weather stain" or "water rot." It was evident that in a certain number of sheep the fleece was suitable for bacterial growth except for adequate moisture which was later supplied by heavy, continuous rains. Much remains to be done on the bacteriology of the affected wool, but one organism associated with many of the cases of "weather stain" was *Pseudomonas aeruginosa* (*Bacillus pyocyaneus*). This species had been recorded from wool some time previously by Seddon and McGrath (24), and by Waters (29), and was isolated by Dr. M. J. Mackerras from wool which we collected. Confirmation that there is always a high bacterial count in wool prior to strike has since been obtained by C. R. Mulhearn and M. J. Mackerras.

Since the association of fly-strike with bacterial activity has been definitely established, it will be evident, after brief consideration, that "body strike" and "crutch strike" are essentially only phases of the same problem. In the case of "body strike," adequate moisture for bacterial development is supplied by rain and wet grass aided by dull or humid weather. In crutch strikes, which are in the main restricted to female sheep, the moisture is supplied by urine and wet faeces, while the maintenance of moist conditions in the breech is favoured by a high relative humidity. It is probable that the part played by the faeces when present alone is negligible, for male sheep are seldom struck in the crutch. Further, Cousin found that oviposition by *L. sericata* in faeces was restricted to the faeces of carnivora. It is

thus improbable that oviposition in soiled wool is due to the presence of the faeces as such, though it is possible that faeces may play a part in some way not yet fully understood.

As regards urine, it is possible that it acts as a skin irritant, but preliminary experiments indicate that it is detrimental to the development of larvae of primary flies. It appears then that the part which both urine and wet faeces undoubtedly play in crutch strikes is mainly that of wetting agents. The fact that fly eggs are often laid an inch or two away from the urine-stained wool, and also the fact that the larvae often move away from the "daggy" stained wool support this contention.

In another article it is proposed to discuss the conditions in wool which favour bacterial activity. The dead cells sloughed off from the skin and those passed out from the skin glands are no doubt important in contributing protein material, while of particular importance is the state of the wool yolk*. In crutch strikes, wrinkles play an important rôle in the retention of moisture. Further, the composition of the wool yolk on folds is different from that away from the folds. (Stewart and Rimington (27)), This also has a relation to bacterial activity in the crutch, and will be discussed at a later date. However, for the present, the main point is that it is necessary to conclude, as Seddon (26) has already done, that crutch strikes and body strikes are similar in that an essential predisposing feature of both is bacterial activity following wetting.

Our knowledge of the actual volatile substances which attract female blowflies to wool for oviposition is still incomplete. Raw wool is a medium composed of a number of complex substances—the wool fibre, wool yolk, and cell debris associated with it. The information available suggests that the volatile substances are the products of chemical changes in the constituents of the fleece as a result of bacterial activity. M. R. Freney (12) has recently shown that the products of hydrolysis of the wool fibre attract primary blowflies. The study of the chemical reactions associated with bacterial activity in wool should yield further information for our understanding of this aspect of strike.

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* Wool yolk, which is associated with the wool fibre and prevents matting, comprises, in the main, ether-soluble fats from the sebaceous glands, and the water-soluble suint or sweat from the sudoriferous or sweat glands.

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Caseous Lymphadenitis—The Disinfection of Shearing Machine Handpieces.

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As infection of sheep with caseous lymphadenitis appears to result in the majority of cases from entry of the causal micro-organism through wounds of the skin, special attention has been drawn to the skin wounds occurring during shearing. It has been found that about 10 per cent. of infected sheep show evidence of rupture of superficial lymph glands, allowing the contents of the abscesses to run out into the wool. It is often observed also that lesions rupture during the process of shearing, due to pressure upon abscesses which are just about to break through the skin. The possibility of the shearing machine passing through such discharges, and thus becoming contaminated, presents a very ready means of transmission of the infection by the combs and cutters to subsequent skin wounds, which are inevitable in any but the plainest bodied types of sheep.

The following experiments were carried out with the object of finding a suitable means of disinfecting the shearing machine handpieces. During 1931, experiments were carried out using watery solutions of certain coal tar disinfectants, but complaints were made by the shearers that the frequent dipping of the hot handpieces into such watery solutions led to the lubricating oil being largely removed, with the result that combs and cutters had to be sharpened unduly often, and there appeared to be some danger of the oil being removed from the bearings of the handpiece.

Examination of handpieces after use showed that, under ordinary conditions, the crevices on the under surface of cutters became partly filled with a mass of greasy yolk, &c. It is believed that the heat generated by friction while the machine is running is sufficient to destroy any Preisz-Nocard bacilli which come into immediate contact with the combs or cutters; but where the yolk or pathological exudate is able to collect in a fairly thick layer, destruction of the micro-organisms will not take place.

It was proposed to disinfect handpieces after each sheep was shorn. There being but a short interval elapsing between the completion of one sheep and the commencement of another, disinfection required to be effected in a very short period while the shearer was catching his next sheep. The practice in earlier experiments in shearing sheds had been to dip the handpiece into a shallow layer of disinfectant in a kerosene tin immediately after completion of shearing. This dipping was only momentary, and then the handpiece was allowed to hang from its stand till the next sheep was caught. In order to effect rapid penetration of the masses of yolk and greasy caseous material which accumulate on the combs and cutters, it was deemed advisable to incorporate a fat

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solvent in the vehicle in which the disinfectant was incorporated. For this purpose, heavy mineral naphtha was selected as being cheap and efficient.

In the first series of experiments, the disinfectant was incorporated in a mixture of mineral naphtha and a lubricating oil commonly employed for lubrication of handpieces, the object being to avoid removal of lubricating oil during the process of disinfection. In later tests, the lubricating oil was omitted.

Technique.—Cutters from shearing machines, after thorough cleansing to remove all greases, were sterilized by autoclaving in petri dishes. They were then contaminated by smearing fresh caseous material from a natural lesion over the upper surface in a thin layer, and beneath, in the depressions on the under surfaces of the blades, a small mass of caseous material was deposited, just sufficient to fill the hollow tip. Such contaminated cutters were then immersed for 30 seconds at room temperature in the disinfectant solution to be tested. They were then removed and rapidly drained, and with a sterile swab the caseous material was rubbed off the upper surface. This was then rubbed up in serum broth. The masses from beneath were similarly removed and transferred to a second tube of culture media. The culture tubes were then incubated together with tubes sown from untreated caseous material from the lesion. Each test was duplicated.

The results of the various disinfectant mixtures are shown in the accompanying table.

Disinfectant.	Concentration of Disinfectant.	Vehicle.	Result.	
			Thin Layer.	Thick Layer.
Cresylic acid..	0·5%	Mineral naphtha 20%, lubricating oil 80%	+	+
Cresol (98%)	10%	Mineral naphtha 30%, lubricating oil 70%	+	+
Tricresol ..	10%	,, ,, ,,	+	+
Titrol ..	10%	,, ,, ,,	+	+
Titrol ..	1%	Mineral naphtha ..	+	+
Titrol ..	5%	,, ,, ..	+	+
Titrol ..	10%	,, ,, ..	+	+
Titrol ..	50%	,, ,, ..	+	+
Cresylic acid..	1%	,, ,, ..	+	+
Cresylic acid..	5%	,, ,, ..	—	+
Cresylic acid..	10%	,, ,, ..	—	+
Cresylic acid..	50%	,, ,, ..	—	—

\+ = Viable organisms recovered.
— = No viable organisms recovered.

The results of these experiments indicate that adequate sterilization with such a short exposure can be effected only by using disinfectants in considerable concentration. Admittedly the test employed was a severe one, because in practice the heat of the machine, generated by friction, is considerable, and would increase both the rate of penetration and the action of the disinfectant. In addition, it has been found in earlier field experiments that large accumulations of grease, &c., do not collect on the combs and cutters if these are dipped after each sheep.

Of the disinfectants used, cresylic acid proved to be the most satisfactory, but was capable of destroying all organisms only when used in a concentration of 50 per cent. in mineral naphtha. The addition of lubricating oil to the vehicle greatly reduced the efficiency of the disinfectant.

Because of the cleansing effects of the frequent immersion of combs and cutters of the handpiece into the disinfectant observed in field experiments, and the probable sterilization by heat of the organisms in immediate contact with the hot metal, it is considered that a concentration of 10 per cent. cresylic acid in mineral naphtha would be the most suitable of the disinfecting fluids tested. Cresylic acid, being a by-product of gas works, is comparatively cheap, and can be purchased in 5-gallon drums at 4s. 6d. per gallon. It consists of the higher fractions of the phenols, from which the carbolic acid and the cresols have been separated. Mineral naphtha costs from 2s. 3d. per gallon in 5-gallon lots.

We wish to express our great indebtedness to H. Finnemore, Esq., Lecturer in Materia Medica and Pharmacy of this University, whose advice was sought concerning the most suitable disinfectants and vehicles to use, and who kindly undertook the preparation of all the fluids tested.

A Soil Survey of Part of the Murrabit Irrigation Settlement (Vic.) and of the Bungunyah Irrigation Settlement (N.S.W.)

By T. J. Marshall, B.Sc.(Agr.) and F. Penman, M.Sc.†*

Summary.

Four new soil types have been identified and described at the irrigation settlements of Murrabit and Bungunyah.

Mechanical and chemical analyses are given, and particular reference is made to soil reaction, replaceable bases, and the bearing of the results on the use of gypsum and lime.

A comparison is made between the major soil type of each of these settlements and the river flat soils previously described in the soil survey of the Woorinen district.

1. The Murrabit Irrigation Settlement.

At the request of settlers, a soil survey was carried out at Murrabit, near Kerang, Victoria, to assist in the investigation of the general unthrittiness of many of the local citrus groves. The distribution of the planted blocks being scattered, a section known as Tye's Estate, having the greatest concentration of plantings, was selected for detailed soil survey. Results of the work reported here will probably be applicable to the remaining river flat land at Murrabit.

Tye's Estate is an area of 950 acres in the Parishes of Benjeroop and Murrabit West, and is part of the Murrabit Irrigation Settlement. It is entirely river flat land, and the only topographical feature is the depression known as Reedy Creek. The estate is only partly planted, and those blocks which have been improved are concerned almost entirely with citrus production. The remaining unimproved blocks constituting the bulk of the area are utilized for occasional crops, rough pasture, and, in a very few instances, for sown pasture.

The citrus groves in the Murrabit district as a whole constitute a small proportion of the total available area, and successful plantings are found generally on the blocks situated nearest the river. In general, Murrabit fruit is of high quality and has an excellent reputation. On Tye's Estate, plantings have been made on blocks well back from the river frontage, and the results have not been entirely satisfactory. The general backwardness of the greater number of the groves on the estate may be attributed to two main factors—frosts and soil conditions, associated in some instances with inadequate cultivation and irrigation practice. Bad frost periods have occurred during the drier winters. Thermograph records kept by Mr. J. A. Egan show that in 1929

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SOIL SURVEY OF TYE'S ESTATE

PARISHES OF
MURRABIT WEST AND BENJEROOP
COUNTY OF GUNBOWER

FIG. 1.

there were over 25 occurrences of frost, and that on nine occasions the temperature remained below 32° F. for a longer period than ten hours. Serious effects have followed the more severe frosts, and, as a precautionary measure, the lighting of heaters has been resorted to on some occasions. The check given to the growth and health of the orange trees must be a matter of great importance at Murrabit, but it does not account in full for the general lack of vigour.

(1) *Soil Types.*—Two soil types were described as a result of the soil survey, and their distribution is shown on the soil map (Fig. 1).

(*a*) *Murrabit Clay.*—This type covers the greater part of Tye's Estate, and is no doubt the chief soil of the Murrabit river flats. It is heavy throughout its profile, with a surface which is very difficult to work and to irrigate. The high clay content of the surface is maintained throughout the profile, which is illustrated in Figure 2A. Mechanical analyses (Table 1) show the texture of every sample taken to be that of a heavy clay. Soils of this nature present at the outset great obstacles to successful citrus production, and, moreover, tillage costs must always be an expensive item. The question of the improvement of the surface conditions, with respect to tilth and acidity, by the addition of gypsum or lime is discussed later.

A variant from this type, which occurs to a very limited extent on the estate, is mapped separately, and is indicated by the words "gypsum present in profile." This soil covers 14 acres, and yields but poor results with citrus.

(*b*) *Benjeroop Clay.*—In surface appearance, Benjeroop clay is similar in the field to the more common type described above, but on analysis it is seen to be rather lighter in texture (Table 1). The fundamental difference, however, is the presence at a depth of about 4 feet of notable amounts of fine sand, which increase with depth (Fig. 2B). The soil appears to be more satisfactory for citrus than Murrabit clay, and it is thought that many of the successful groves outside the area surveyed owe their success, in some part at least, to location on this more suitable soil type. It is probable that the type is of most common occurrence along the river frontage. The area within the estate is only 50 acres.

Murrabit Clay.

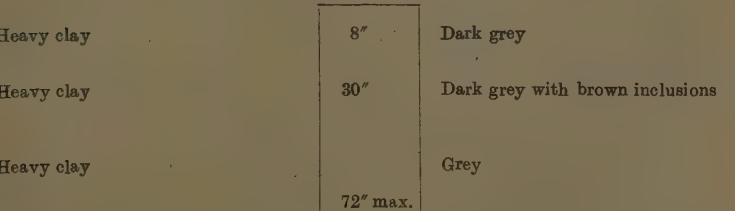

Fig. 2A.

Benjeroop Clay.

Medium clay	8″	Dark grey
Medium clay with light brown inclusions	24″	Dark grey
Medium clay with brown fine sand in pockets	48″	Grey
Sandy clay, sand increasing		Brown
	72″ max.	

FIG. 2B.

TABLE 1.—MECHANICAL ANALYSES AND OTHER DATA FOR MURRABIT AND BENJEROOP CLAY PROFILES.

(Figures represent percentages on air-dry soil, with the exception of pH.)

Soil Type.	Murrabit Clay.								Benjeroop Clay.		
Sample No.	638/31/11	12	13	14	638/31/19	20	21	22	638/31/1	2	3
Depth in inches	0-8	8-24	24-48	48-72	0-8	8-33	33-53	53-73	0-8	8-24	24-48
Coarse sand	0·2	0·1	0·2	0·2	0·6	0·6	0·6	0·4	5·8	5·8	7·4
Fine sand	15·0	15·7	17·9	23·3	19·0	15·9	14·9	12·9	27·8	27·5	30·6
Silt	19·9	18·4	20·1	26·1	23·3	23·2	22·6	24·8	13·2	16·1	13·6
Clay	57·3	61·0	56·5	47·5	52·2	55·3	56·7	56·8	46·8	44·6	42·7
Loss on acid treatment	3·6	3·3	3·3	2·2	2·5	2·1	2·0	2·2	3·0	2·1	2·8
Loss on ignition	9·7	8·9	7·6	5·7	7·5	6·5	6·5	6·0	7·6	9·7	6·0
Total salts	0·06	0·08	0·16	0·19	0·06	0·03	0·03	0·07	0·03	0·08	0·12
Chlorine	0·02	0·02	0·07	0·07	0·01	0·00	0·01	0·02	0·01	0·04	0·06
Total nitrogen	0·08	..	..	..	0·11	..	..	..	0·09	0·03	..
pH	6·5	6·0	7·1	7·7	6·4	6·1	5·8	6·7	6·7	6·2	7·7

(2) *Chemical Analysis.*—Analyses of hydrochloric acid extracts of typical Murrabit soils are shown in Table 4. Phosphoric acid is low and lime moderate, while potash and magnesia are high, the latter exceeding lime in all cases. Total nitrogen figures, as listed in Tables 1 and 2, are normal for heavy soils in this region, as is also the distribution of nitrogen in the soil profile.

The replaceable base figures listed in Table 5 characterize the Murrabit clay complex in surface and sub-surface samples as calcium-magnesium dominant, these two cations being present in roughly equal amount, and together constituting nearly 80 per cent. of the total replaceable bases. There is no free calcium carbonate in these soils, and the reactions of surface samples range closely round an average figure of pH 6.6. Reaction values of all Murrabit samples examined are set out in the form of a distribution table (Table 6).

Tables 2 and 3 show that, in general, chloride is the most important anion in soluble salt extracts. Figures for chlorine as shown in the tables represent chlorine in the form of chloride. From Table 3, and on comparison with similar soils of northern Victoria, soluble salt is attributed chiefly to sodium chloride and sodium sulphate, lime and

magnesia being of little importance. Bicarbonate is low compared with the calcareous alkaline soils of most of the Murray irrigation districts. It will be noted from Table 2 that chlorine reaches figures as high as 0.08 per cent. in some subsoils, and total salts, excluding the gypsum-bearing soil, reach 0.23 per cent. It is considered that in heavy soils of this character such figures for subsoils are not unduly high.

TABLE 2.—TOTAL NITROGEN, TOTAL SOLUBLE SALTS, AND CHLORINE IN MURRABIT CLAY AND BENJEROOP CLAY SAMPLES.

(Figures represent percentages of air-dry soil.)

Soil Type.	Murrabit Clay.						Benjeroop Clay.				Gypsum Bearing Soil.		
Sample No. ..	638/31/15	16	17	18	23	24	638/31/7	8	9	10	638/31/4	5	6
Depth Inches ..	0–8	8–30	30–58	58–72	0–6	6–24	0–8	8–24	24–40	40–60	0–10	10–24	24–42
Total nitrogen ..	0·09	..	..	..	0·09	0·05	0·11	..	..	..	0·06	..	..
Total salts ..	0·07	0·07	0·15	0·17	0·10	0·23	0·06	0·08	0·12	0·07	0·09	0·23	*0·65
Chlorine ..	0·02	0·02	0·05	0·05	0·02	0·08	0·01	0·01	0·02	0·02	0·02	0·07	0·11

* Containing gypsum.

TABLE 3.—ANALYSES OF SOLUBLE SALTS IN MURRABIT SOILS.

(Figures represent parts per 100,000 of air-dry soil.)

Sample No. ..	638/31/3	5	17	19	22	24
Depth Inches ..	24–48	10–24	30–58	0–8	53–73	6–24
Total salts ..	120	225	150	55	70	230
Cl	48	68	45	5	15	77
CO_3	nil	nil	nil	nil	nil	nil
HCO_3 ..	12	10	20	13	9	14
SO_4	13	63	36	8	8	62
Ca	1	7	1	1	0	5
Mg	2	5	2	2	1	7

TABLE 4.—CHEMICAL ANALYSES OF MURRABIT AND BUNGUNYAH SOILS.

(Per cent. air-dry soil.)

Soil type	Murrabit Clay.		Benjeroop Clay.		Bungunyah Clay.	
Sample No.	638/31/11	19	638/31/1	2	2389	2399
Depth Inch	0–8	0–8	0–8	8–24	0–12	0–15
P_2O_5	0·08	0·08	0·05	0·05	0·04	0·04
K_2O	0·85	0·79	0·68	0·66	1·03	0·97
CaO	0·38	0·24	0·27	0·26	0·65	0·57
MgO	0·48	0·37	0·41	0·59	0·76	0·78

TABLE 5.—REPLACEABLE BASES OF MURRABIT AND BUNGUNYAH SOILS.

Soil type	Murrabit Clay.		Benjeroop Clay.	Bungunyah Clay.	
Sample No.	638/31/11	12	638/31/2	2389	2399
Depth—Inch	0–8	8–24	8–24	0–2	0–15
pH	6·5	6·0	6·2	7·9	7·4
Total replaceable base mgm. equivalent per cent.	33·3	30·5	26·0	29·7	28·9
Per cent. of total replaceable bases—					
Ca	43	33	33	53	57
Mg	35	43	43	26	27
Na	18	21	20	15	10
K	4	3	4	6	6
Clay percentage	57·3	61·0	46·8	43·0	46·9

TABLE 6.—DISTRIBUTION TABLE FOR pH.

(Figures represent numbers of samples falling into each reaction range. Samples below 4 feet are not included.)

Reaction pH.	4·5–4·9.	5·0–5·4.	5·5–5·9.	6·0–6·4.	6·5–6·9.	7·0–7·4.	7·5–7·9.	8·0–8·9.	8·5–8·9.
Swan Hill clay	1	2	1	1	1	..	..	..	..
Murrabit clay	..	..	2	5	5	1	..	..	..
Benjeroop clay	..	..	..	1	2	1	2	..	..
Bungunyah clay	..	..	..	..	2	4	4	1	2
Beverford clay loam	..	..	..	..	..	..	..	8	9

(3) *Discussion of Murrabit Soils.*—It is generally supposed at Murrabit that the soils there are all highly acidic, but this view has not been supported very strongly by the determinations recorded in Table 6. While practically all samples from the Murrabit clay soil type are definitely acidic, the degree of acidity, in surface samples at any rate, is in no case great enough to warrant concern. Lime has in the past been used in considerable quantities by some growers with the object of overcoming acid conditions. That this can be readily accomplished is shown by the fact that in two cases where this treatment had recently been adopted, an alkaline reaction (pH 7.7 and pH 8.0) was found for surface samples. These were the only alkaline surface samples taken at Murrabit, and because of the special treatment they had received the results have not been recorded on the pH distribution table.

The replaceable base figures are of considerable interest. The soils at Murrabit compare rather unfavorably with Bungunyah clay in respect to replaceable calcium, and this, coupled with their somewhat higher clay content, probably accounts for their inferior surface texture. The use of lime and gypsum with the aim of remedying this defect has been adopted fairly generally. Both materials will effect a gradual

improvement in the general condition of the soils by building up a calcium clay. Lime, of course, will have the additional value of correcting acidity where this is considered necessary, and is recommended for most soils of the district.

The problem at Murrabit, so far as it concerns the soil, is linked up with textural conditions rather than with infertility or acidity. Efforts at improvement must centre around the application of lime and gypsum, and notable results will necessarily be slow owing to the very high clay content of the soil. Normal fertilizer applications of nitrogen and phosphoric acid in some form are, of course, advisable in addition.

In watering of Murrabit soils, which in general may be considered free from seepage and salt troubles, and in which the chief problem is the extremely slow penetration of water, irrigation practices involving flooding or semi-flooding would appear to be the most satisfactory.

2. The Bungunyah Irrigation Settlement.

(1) *General.*—The Bungunyah-Koraleigh Irrigation Trust District is situated on the New South Wales side of the Murray River, opposite Nyah (Victoria), on a low flat, at a level formerly reached by high floods. To the east, the ground dips into Lakes Wollare and Goonimur, and to the west it rises to the Mallee country. The intervening strip includes about 1,400 acres of land, most of which is irrigable from low lift channels; of this area, only about 500 acres have so far been planted. Plantings consist chiefly of sultanas, with oranges occupying the major part of the remaining irrigated land. The flat is rather subject to frosts, and during 1928 and 1929 citrus growers experienced a good deal of trouble from this source. Taken generally, the trees have not come forward successfully since then, and at the time of the survey only occasional good groves were encountered.

The soils are mainly heavy and dark, the texture of the major type varying from a medium to a heavy clay, and the colour from dark-grey to black. Excluding the brown Mallee soils which project in places into the flat, the soils may be divided into two main types—Bungunyah clay and Koraleigh sandy loam, of which the former is by far the more important (*vide* soil map, Fig. 3).

Bungunyah Clay.—This soil type, the profile of which is sketched in Figure 4A, covers the greater part of the settlement. The depth of the dark-coloured horizon varies very considerably, and in local patches the surface is grey. In some borings the depth of the black clay was 26 inches, but in more than half the soils it was not greater than 12 inches. In the surface 2 feet of soil, lime was found in very limited amounts, if at all. In the subsoil, it was usually present in appreciable but never large amounts in association with fine limestone rubble. The soil, although very heavy and intractable when wet, becomes more friable and works into a reasonably good tilth when dry. The reaction of the normal profile is alkaline, but not highly so in the surface soils. Plant food analyses (Table 4) disclose the usual high potash and low phosphoric-acid content common to most Murray River soils. Total

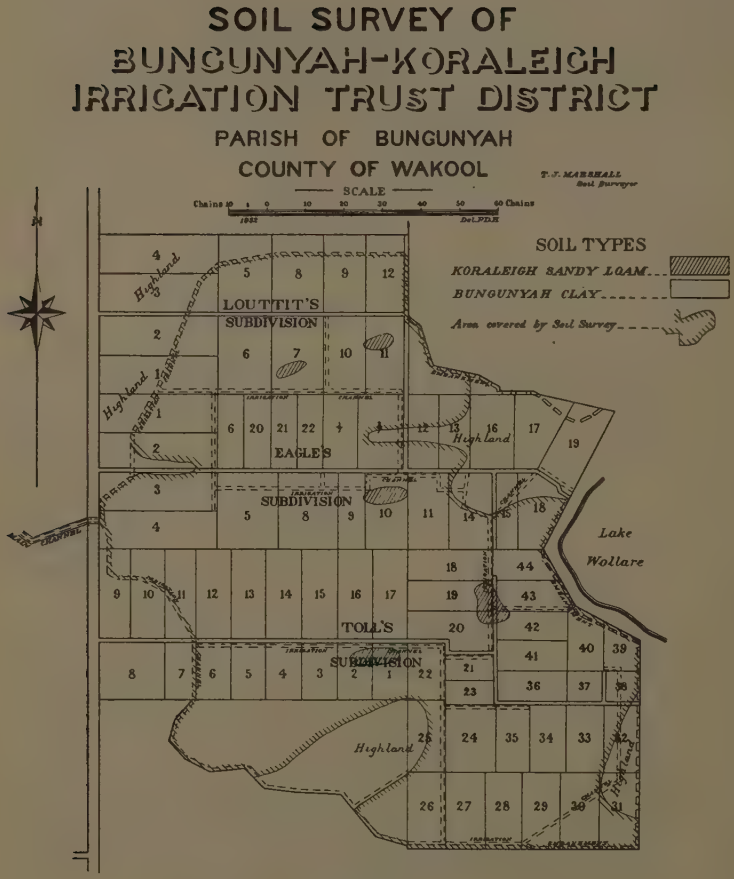
SOIL SURVEY OF
BUNGUNYAH-KORALEIGH
IRRIGATION TRUST DISTRICT
PARISH OF BUNGUNYAH
COUNTY OF WAKOOL
T. J. MARSHALL
Soil Surveyor
SCALE
Chains 10 1 0 10 20 30 40 50 60 Chains
1932
Del. P.D.R.
SOIL TYPES
KORALEIGH SANDY LOAM
BUNGUNYAH CLAY
Area covered by Soil Survey
LOUTTIT'S
SUBDIVISION
EAGLE'S
SUBDIVISION
TOLL'S
SUBDIVISION
Highland
Lake
Wollare

FIG. 3.

nitrogen figures, as shown in Table 7, are fairly high for surface and sub-surface samples when the depth of sampling is considered, one figure being 0.17 per cent. for the surface foot.

There are three variants from the normal Bungunyah clay soils, the most important of which appears, in the field, to be of a somewhat lighter texture. This is reflected in the mechanical analysis of samples 2389, 2390, and 2391 (Table 7). Otherwise, the soil presents no marked differences from the more usual type represented by samples 2399, 2400, and 2401.

A second variant occurs in blocks 40, 41, and 42 (Toll's subdivision) on land which has only recently been reclaimed, and has hitherto been subjected to repeated inundation. The soils here are exceptionally heavy (samples 2395-7) and slightly acid, and do not work down to the tilth of the normal type. Otherwise, the profile presents no great differences.

A third variant is found in blocks 34 and 35 (Toll's subdivision), which is also a low-lying area. Here the soils are greyer in colour, but still fairly high in nitrogen. Although also slightly acid, the surface does not present the same working difficulties as the heavy surfaced soils described above.

Koraleigh Sandy Loam.—This soil is of high productive capacity, but it is limited in extent to an area of 23 acres. The soils are light and highly alkaline. A typical profile is illustrated in Figure 4B, and

Bungunyah Clay.

Medium clay	12″	Black
Heavy clay with slight lime	20″	Grey black
Heavy clay with light lime and rubble		Grey

FIG. 4A.

Koraleigh Sandy Loam.

Sandy loam	15″	Dark grey
Sandy loam	26″	Brown
Sand with slight rubble		Brown

FIG. 4B.

Table 7.—Bungunyah Soils—Mechanical Analyses and other Data.

(Figures represent percentages of air-dry soil, with the exception of pH.)

Soil Type.	Bungunyah Clay.											Koraleigh Sandy Loam.		
Sample No.	2399	2400	2401	2389	2390	2391	2395	2396	2397	2398	2388	2392	2393	2394
Depth Inches	0–15	15–30	30–50	0–12	12–30	30–50	0–11	11–18	18–38	38–58	0–12	0–15	15–36	36–56
Coarse sand	14·6	14·9	11·6	16·6	15·0	15·8	8·4	8·8	9·2	..	..	29·0	30·8	..
Fine sand	28·3	26·8	25·0	31·6	29·2	30·6	25·0	24·0	25·2	..	..	47·4	45·3	..
Silt	5·7	5·5	6·0	5·1	5·4	5·7	7·2	6·6	6·8	..	..	4·9	3·1	..
Clay	46·9	48·7	51·0	43·0	45·4	41·7	54·2	55·1	54·7	..	..	15·3	18·9	..
Loss on acid treatment	1·8	1·7	5·5	1·9	4·5	6·1	1·6	1·8	1·9	..	..	0·6	4·0	..
Loss on ignition	5·1	4·6	5·5	4·7	5·0	5·3	5·9	5·5	4·7	..	..	2·7	4·1	..
$CaCO_3$	tr.	..	4·0	0·2	3·1	4·7	..	..	..	..	..	..	..	..
Total salts	0·04	0·05	0·11	0·09	0·16	0·16	0·09	0·05	0·08	0·21	0·08	0·05	0·10	0·10
Chlorine	0·01	0·01	0·02	0·02	0·05	0·03	0·01	0·01	0·02	0·04	0·01	0·01	0·02	0·01
Nitrogen	0·10	0·07	0·03	0·08	..	..	0·10	..	..	..	0·17	0·05	..	..
pH	7·4	7·9	8·5	7·9	8·0	8·7	6·8	7·2	7·4	7·9	6·8	9·0	9·0	9·5

the mechanical analyses are shown in Table 7. Soils of a heavier texture are also met with, and lime was found in the profile at a depth of about 15 inches in a number of borings.

(2) *Discussion of Bungunyah Soils.*—The problem of major importance at Bungunyah is the poor grade of dried fruit produced. Heavy yields are obtained, but with the exception of the small area of Koraleigh sandy loam, which is claimed by the owners to grow superior fruit, the sultanas are on the whole of low grade. The inference is that the adverse factor lies in either the soil or the climatic conditions. The latter are known to be unsatisfactory for the later stages of the harvest. In view of the high yield, it seems certain that the soil moisture and nitrogen supplies are ample. The production of abundant foliage and good cane growth are always associated with a sufficiency of nitrogen, and, considering the typical figure of 0.10 per cent. in the surface soil, nitrogenous fertilizer seems unnecessary until the vines show signs of weakening. This should not occur with a regular green manuring system. Any treatment which will increase the sugar-content and advance the ripening period is of primary importance, and from analogous instances it is highly probable that, while potash tends to promote this end, excess nitrogen tends to depress the sugar and put back the date of maturity. Despite the high content shown by analyses of the soils, potash may not necessarily be in a readily available form, and potash fertilizers deserve close attention in the experimental plots at present being conducted at Bungunyah.

The value of superphosphate as an essential fertilizer is emphasized, and it is considered that moderately heavy dressings of about 4 cwt. per acre on sultanas would give economic returns. In any case of intractability of surface soil or slow penetration of irrigation water, applications of gypsum or lime, whichever is the cheaper, would produce an improvement. Green manure crops in alternate rows annually, or at least two out of three years, should be a standard practice.

In the case of oranges, nitrogenous fertilizers are probably necessary, but the value of experimental dressings of other fertilizers should not be disregarded. The danger of frost damage seems sufficiently great to prevent any further planting of citrus, and the future of the settlement depends on the improvement of the sultana crop.

3. A Comparison of River-flat Soils of the Swan Hill District.

Soil surveys conducted within the region of Swan Hill have now defined four soil types having texture and profile characters in common. These occur on the river flats at Bungunyah, Murrabit, Beverford, and Speewa, and have been called Bungunyah clay, Murrabit clay, Beverford clay loam, and Swan Hill clay.* They are all heavy soils of alluvial origin. It would appear from Table 6, showing the reaction of the soils, that the Speewa flat was the most recently under the influence of floods from the Murray River, and that Beverford clay loam has been independent of river action for a longer period than the other soils.

* Beverford clay loam and Swan Hill clay are described in C.S.I. R.Bulletin No. 45, 1930, as Types 9 and 10 respectively.

On the triangle diagram (Fig. 5), illustrating mechanical analyses of soils, Murrabit clay and Bungunyah clay samples group well, and are shown to be very heavy. A comparison of the groups indicates a relationship between the Murrabit and Swan Hill clays, and between the Bungunyah clay and Beverford clay loam, and this concordance is supported by the pH distribution table. Summation curves (Fig. 6) illustrate in addition the absence of coarse sand in the Swan Hill clay and Murrabit clay soils. These curves have been drawn on averages for surface samples only, but adequately present the salient features of the soil types.

Results of soil surveys of these four river flats suggest that a close connexion would be obtainable between all similar flats in this district of comparable height above river level. The difference between the soils would lie mainly in reaction, depending on the time that has elapsed since the flat reached a level above the regular influence of high rivers.

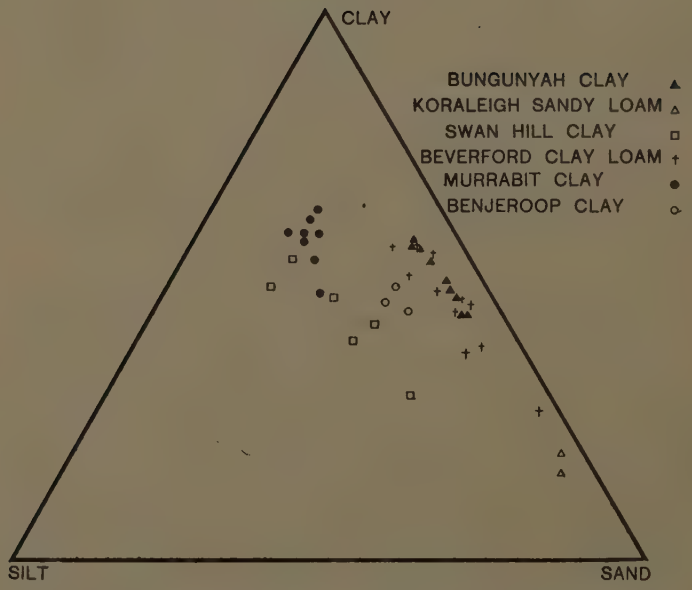

Fig. 5.—Distribution triangle illustrating mechanical analyses of soil types.

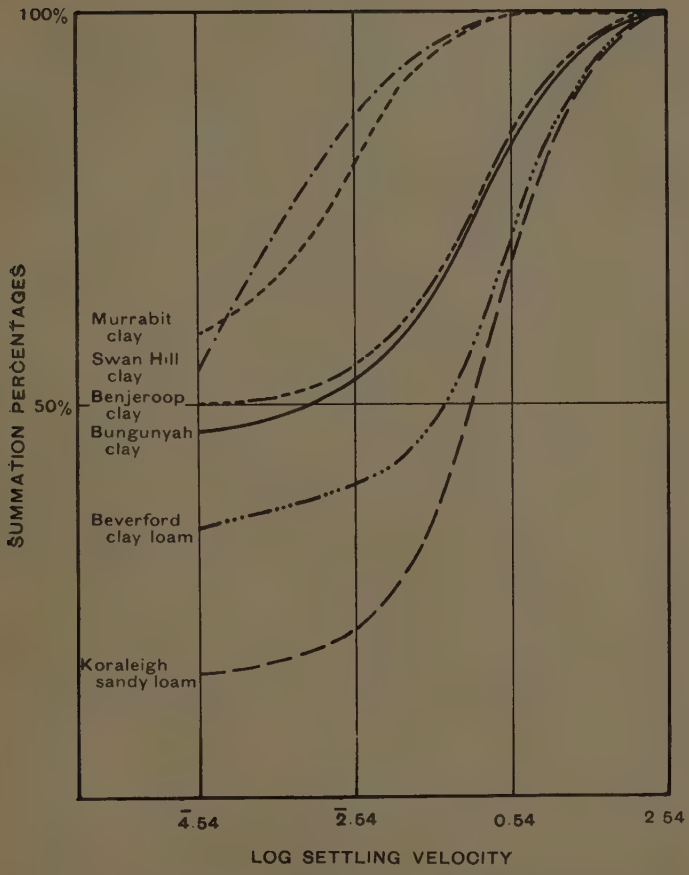

FIG. 6.—Summation curves illustrating average mechanical analyses of surface samples of soil types.

The Sulphuring of Apricots.

*By J. E. Thomas, B.Sc., B.Agr.Sc., B.V.Sc.**

Summary.

1. Under field conditions, the amount of SO_2 (sulphur dioxide) absorbed in drying apricots is closely related to the time of exposure to the fumes in the sulphuring chamber and to a minor degree to the amount of sulphur burnt.

2. The method of drying after sulphuring has an important influence on the SO_2 content in the resultant product; shade drying leads to a loss while sun drying appears to preserve the SO_2 content of the dried sample.

3. Heavy spraying or allowing to stand overnight before sulphuring appears to have little significant influence on the SO_2 content.

4. An estimate of the probable amount of SO_2 absorbed may be obtained in the field by applying an iodine test to the freshly sulphured fruit.

5. Under storage conditions a heavy loss in SO_2 occurs; there is reason to believe that the losses in moist packed fruit are heavier.

6. The re-processing of apricots is discussed. The rate of SO_2 absorption on resulphuring is shown to be correlated with the moisture content. Evidence is advanced in support of the contention that, in order to retain a satisfactory colour, re-processed fruit should contain not less than 10 grs. of SO_2 when packed.

1. Introduction.

In June, 1929, it having been found that some samples of Australian dried apricots contained more sulphur dioxide than the maximum amount permitted under British Health Regulations, a conference of representatives of the Council and of the State Departments of Agriculture concerned was held to formulate a programme of research into the whole problem. As a result the investigation of certain aspects of the problem was allocated to the Council. Work on these aspects was commenced in 1930, and the results of that season's investigations have already been published (this Journal **3**: 161, 1930). During the subsequent year, studies were continued at Curlwaa, New South Wales, by the staff of the Commonwealth Research Station, Merbein, with the field assistance of Mr. McCutcheon, Horticultural Instructor, Department of Agriculture, New South Wales. The results of these studies are discussed below.

2. Experimental Methods.

The sulphur hoods used were those employed in the 1930 experiments,† and the procedure was, in all cases, very similar. During the trials, at half hour intervals, wet and dry bulb records were taken within the hoods. The thermometers were placed near view glasses about two-thirds up from the bottom of the chambers, and at the end distant from the entry of the sulphur fumes. Owing to the great variation in temperatures in different parts of the hood, however, the temperature records are of value for comparative purposes only.

The "Moorpark" variety of apricot was used and, unless otherwise specified, the fruit was sun dried. The methods of sampling and analyses employed were in accordance with the recommendations of

* An officer of the Commonwealth Research Station, Merbein.

† Lyon, A. V. "The Sulphuring of Apricots." This *Journal* **3**: 161, 1930.

Mr. W. R. Jewell, Secretary to the Committee. For determination of moisture, the vacuum oven method* was found unsatisfactory, and a direct distillation method was used instead†. Determinations of SO_2 content in the dried fruit were made, by the official A.O.A.C. method, from 5 to 7 weeks after sulphuring.

3. Results.

(i) *Study of the Absorption of SO_2.*—In order to control the rate of burn, the sulphur was burnt in a small pit outside the hood and the fumes admitted to the latter through a 3-inch pipe with an adjustable aperture. A number of additional exits which could be closed at will, and additional to those previously described by Lyon, were made, thus facilitating the alteration of the draught, and hence, the rate of burn of the sulphur. In practice, however, under field conditions, it was found difficult to burn a predetermined amount of sulphur in a given time.

The results obtained when sulphuring by burning the same amount of sulphur at different times are shown in Table 1. Those obtained when burning variable amounts of sulphur in a constant time are given in Table 2.

From the results detailed in Table 1, it will be seen that the amount of SO_2 absorbed by the fruit bears a fairly close relation to the time of exposure. An inspection of Table 2 discloses that wide variations in the amount of sulphur burnt have relatively little influence in the SO_2 content of the dried product under comparable conditions from the point of view of length of time of exposure. Under field conditions, there are other uncontrollable factors operating such as temperature and weather during the drying period (see next section). For this reason, comparisons of varying SO_2 content should be limited to any one experiment.

Table 1.—SO_2 Absorption when a Constant Amount of Sulphur was Burnt in a Variable Time.

Expt. No.	Time of sulphuring. (hours.)	Amount of sulphur burnt (lb./ton fresh fruit.)	Mean hood temperature. (Deg. F.).	Mean shade temperature of atmosphere at the time. (Deg. F.).	SO_2 content of dried fruit seven weeks later (grains per lb.).	Remarks.
1	3	3·26	110	90	6·5	Sun-dried one day, then shade-dried
	4	3·26	110	90	9·2	
	4¾	3·26	108	90	6·3	
	5½	3·26	109	90	9·4	
2	3½	6·52	96	79	8·3	Sun-dried
	4½	6·52	96	79	10·2	
	5	6·52	96	79	11·5	
	5½	6·52	97	79	11·8	
3	3½	9·30	109	88	11·1	Sun-dried
	4½	9·30	101	88	12·7	
	5	9·30	106	88	14·9	
	6	9·30	101	88	16·1	

* "Methods of Analysis, A.O.A.C." 2nd Edn. 1925, p. 209.
† *Jour. A.O.A.C.* **9**: 30, 1926.

TABLE 2.—SO_2 ABSORPTION WHEN VARIABLE AMOUNTS OF SULPHUR WERE BURNT IN A CONSTANT TIME.

Expt. No.	Time of sulphuring. (hours).	Amount of sulphur burnt (lb./ton fresh fruit.)	Mean hood temperature. (Deg. F.)	Mean shade temperature. (Deg. F.).	SO_2 (grains per lb.).	Remarks.
1	4¾	1·47	88	74	5·9	Sun-dried
	4¾	1·47	87	74	6·2	
	4¾	2·58	87	74	7·0	
2	4¾	3·07	101	83	7·9	Sun-dried
	4¾	3·89	100	83	8·1	
	4¾	4·51	104	83	8·3	
3	4¾	2·75	108	83	5·1	Sun-dried for one day then shade-dried
	4¾	6·51	109	83	7·1	
4	4½	8·98	110	91	10·5	Sun-dried
	4½	9·00	101	91	9·7	
	4½	9·10	101	91	10·4	
	4½	11·30	102	91	11·6	
5	4½	7·46	109	92	7·4	Sun-dried for one day then shade-dried
	4½	9·37	108	92	9·1	
	4½	12·63	109	92	8·8	
6	4½	5·49	108	90	11·0	Sun-dried
	4½	6·34	109	90	14·0	
	4½	6·77	110	90	11·6	
	4½	8·49	110	90	13·8	
7	4	4·00	98	94	9·6	Sun-dried
	4	7·00	107	94	13·2	

NOTE.—With the exception of Experiment 1 in Table 2, the samples obtained from the experiments were of good commercial quality.

During the tests detailed in Table 2, a number of samples of gas were aspirated from the atmosphere in the hood and examined for SO_2 concentration. This was found to fluctuate widely in different parts of the hood ranging from 0.20 per cent. near the entry of the sulphur fumes, 0.05 per cent. along the side, and 0.10 per cent. near the exit. A number of analyses were made of samples from comparable hoods burning varying amounts of sulphur, and, as was to be expected, it was found that the SO_2 concentration tended to increase as the rate of burn increased. Under current field methods of burning sulphur, using the "open" system, the concentration of SO_2 is relatively low, and, in such cases, the hood concentration does not appear to be a major factor controlling absorption. It would appear, however, from the results obtained by Chase, Church and Sorber* in California, that, when the gas concentration is kept at much higher levels (at from 1 to 15 per cent.), the concentration then becomes a prime factor in determining the amount of SO_2 retained.

* Chase, Church, and Sorber. "Large Scale Experiments in Sulphuring Apricots." *Jour. Ind. Eng. Chem.* **22**: 1317, 1930.

(ii) *Sun Versus Shade Drying.*—Experimental work carried out in South Africa* tends to show that shade drying after sulphuring results in a reduction in SO_2 content. In the following tests, immediately after sulphuring, four trays were stacked in the sun. After one day's sun exposure, the top tray No. 1 was taken off, thereby exposing No. 2. On the second day, No. 2 was removed, and on the third day No. 3, thereby exposing No. 4. Owing to the very favorable weather conditions, the drying rate was particularly rapid. The results are given in Table 3.

TABLE 3.

No. of Tray.	Method of Drying.	SO_4 content in grains/lb.			
		Experiment No.			
		1.	2.	3.	4.
1	Wholly sun-dried	10·1	11·4	12·6	11·9
2	One day's shade-drying—then sun-dried ..	8·2	8·9	9·9	10·1
3	Two days' shade-drying—then sun-dried ..	7·9	6·5	8·5	8·8
4	Three days' shade-drying—then sun-dried ..	7·6	6·4*	8·0	6·8*

* Wholly shade-dried.

The samples were graded in terms of colour and, in all four cases, the brightest were those wholly sun-dried, and the dullest the shade dried. The differences were not sufficiently great to have any commercial significance, although a greater diversity of colour might possibly have been obtained under less favorable drying conditions. It is apparent that the shade drying results in a very considerable diminution of SO_2 content and is, therefore, an easy and convenient method of treating fruit suspected of being over-sulphured. These results offer a partial explanation, at least, of anomalies noted in other experiments, for the weather during the drying period may profoundly control the SO_2 content.

(iii) *Influence of Spraying.*—In the report of the 1929-30 experiments carried out at this Station, it was concluded that light spraying with water or a 2.5 per cent. salt solution had little significant effect on the absorption of SO_2. In a recent bulletin by Nichols and Christie†, it is stated that spraying tends to depress the absorption of SO_2. On the other hand, Anderson (loc. cit.) presents some experimental work which indicates an increase in SO_2 content after moistening. For these reasons, some of the 1929-30 experiments were repeated. In each case, the samples "sprayed" were freshly cut and heavily sprayed.

* Anderssen. "Sulphur Dioxide in Dried Fruit." Union of South Africa, Department of Agriculture, Science Bulletin 84 (1929).

† "Drying Cut Fruits." Cal. Agr. Expt. Sta. Bull. No. 485 (1930).

The results are given in Table 4.

TABLE 4.

Position of tray in chamber.	Expt. 1.	SO_2 content (grains/lb.).	Expt. 2 treatment.	SO_2 content (grains/lb.)	Expt. 3 Control.	SO_2 content (grains/lb.)
Top Guard 9	..	..	..	..	..	9·5
8	Sprayed	9·5	Sprayed	6·3		7·9
7	Cut 17 hrs.	9·6	Cut 17 hrs.	6·6	Freshly	9·4
6	Freshly cut	9·4	Freshly cut	5·3	cut.	10·0
5	Freshly cut	7·7	Freshly cut	4·9	All	10·4
4	Cut 17 hrs.	10·7	Cut 17 hrs.	6·1	trays	10·3
3	Sprayed	9·2	Sprayed	6·5		9·7
Bottom Guard 2						
Means ..	Sprayed	9·4	..	6·4		
	Cut 17 hrs.	10·2	..	6·7		
	Freshly cut	8·5	..	5·2		

The results of moisture determinations made on samples cut ½-in. parallel to the cut surface were as follows:—

Freshly cut	86.4 per cent.
Cut 17 hours (overnight)	86.3 „ „
Sprayed	90.1 „ „

The sprayed samples looked brighter and more attractive when removed from the sulphuring chamber, but little if any difference was discernible in the dried samples some 5 weeks later.

From the data presented in Table 4, it does not appear that spraying the fresh fruit or allowing it to stand overnight have any marked effect on either the SO_2 content or the ultimate colour.

(iv) *Application of an Iodine Test to the Freshly Sulphured Apricot.*—It was suggested by Mr. W. R. Jewell that an iodine test might act as a reliable field guide to the amount of SO_2 ultimately retained in the dried sample. Immediately after sulphuring, a composite sample was selected from the trays, the pulp expressed, and strained through muslin. Twenty-five mils. of the pulp were then titrated with N/10 iodine solution using starch as indicator. A blank determination was carried out with fresh un-sulphured apricots. The correction thus obtained varied between 0.25–0.50 mils. of the iodine solution. This test was applied to all the experiments, but in the light of the evidence obtained from the shade drying trials, only the results from samples which were wholly sun dried were used to plot a graph. Although a fairly wide scatter of points was obtained, the correlation co-efficient between the iodine figure obtained on fresh fruit, and the SO_2 content of the sun-dried product was sufficiently high to render the titration figure of value ($r = .61 \pm .14$). For samples containing more than 6 grains of SO_2 per lb. the most probable value could be estimated from the iodine test by use of the following:—SO_2 grains/lb. = mils N 10 iodine—2.0.

(v) *Storage Trials.*—The following table sets out the changes in SO_2 which occurred in samples of dried apricots stored at Merbein.

TABLE 5.

Date.	Time after sulphuring.	SO_2 content (14—17 per cent. moisture). Sample No. 1.	2.	3.	4.
22.2.30 ..	5 weeks ..	10·3	10·7	27·7	17·8
1.3.30 ..	6 weeks ..	9·3	11·3	24·3	n.d.
15.3.30 ..	2 months ..	7·9	10·1	25·0	17·0
15.4.30 ..	3 months ..	8·4	9·7	26·4	15·4
15.7.30 ..	6 months ..	6·1	9·5	21·7	12·5
15.10.30 ..	9 months ..	6·3	8·4	21·6	11·6
15.1.31 ..	12 months ..	5·9	7·4	17·5	9·5

The difficulties of sampling bulk packages are responsible for some apparent discrepancies in the above table. It will be seen that storage losses (probably due to oxidation) are very considerable. There is some evidence to show (Section vi) that the losses in moist packed apricots are much greater than this.

(vi) *Reprocessing of Apricots.*—During recent years, a moist pliable apricot rather than a bright dry one has been in keener demand on the London market. In order to produce the former article, re-processing is a standard packing shed procedure in California and South Africa. After delivery, at the packing shed, the fruit is moistened either by steaming or immersion and is then re-sulphured. This latter step is there considered necessary in order to prevent excessive darkening of the moistened fruit.

By arrangement with the authorities of "Australia House," samples typical of dried apricots being sold on the London market were collected in June, 1931, and forwarded in sealed containers to Merbein for examination, the results of which are given in Table 6.

TABLE 6.

Sample.	Colour grade (Max. 5).	SO_2 content. (grains/lb.)	Moisture content.
Californian—			
Extra Fancy Tilton ..	4½	5·2	19·5—21%
Fancy Tilton	4½	5·0	
Extra Choice	4½	8·1	
Choice	3½	2·5	
South African—			
Three Diamond Royals ..	3½	5·7	21·1—23%
Two Diamond Royals ..	3	4·8	
Australian—			
Four Crown	5	6·6	16·0%
Three Crown	4	6·6	
One Crown	3½	3·2	

The Australian apricots contained approximately 5 per cent. less moisture than the Californian and South African samples.

In Australia, however, owing to the fact that the apricots, when delivered at the packing sheds, contain a higher SO_2 content than similar Californian fruit, it might be expected that some modification of procedure might be required to produce the more pliable and moister fruit in question.

In order to determine whether re-sulphuring might result in an increase in the SO_2 content above the statutory limits, tests were carried out to determine the absorption of SO_2 on re-sulphuring. From the results which are given in Table 7 below, it was found that the amount absorbed was related to the moisture content of the fruit (increasing with that content).

TABLE 7.

Sample No.	Moisture content.	SO_2 content after three hours' re-sulphuring.
	Per cent.	(grains/lb.)
1	22	9·9
2	25	11·5
3	32	14·0
4	36	14·1
5	44	13·1

(NOTE.—The initial SO_2 content of the bulk samples was 8·1 grains/lb.)

(vii) *Storage Tests.*—Over-sulphured fruit may be reduced in SO_2 content by treatment with oxidising agents of which hydrogen peroxide and sodium hypochlorite solutions have been used. A series of sodium hypochlorite solutions containing from 0.1 to 0.5 per cent. of available chlorine were prepared and in these the dried apricot samples were immersed for 15 minutes. By this method a series of samples with varying SO_2 contents ranging from 3 to 9 grains per lb. were obtained. Each sample was adjusted to a 20 per cent. moisture content, and half of each was re-sulphured. Representative samples were forwarded to London and Melbourne in April, 1931, and returned at the end of the year. All showed a considerable colour deterioration which was greater in the case of those returned from London. Only those with the original sulphur dioxide content of 9 grs. or more of SO_2 retained a colour suitable for the trade. Typical losses in SO_2 content are shown below:—

TABLE 8.

Sample No.	Treatment.	SO_2 content after treatment as above in April, 1931.	SO_2 content in December, 1931.		
			Merbein.	Melbourne.	London.
1	Re-sulphured ..	7·5	4·1	1·7	1·1
	Not re-sulphured ..	5·0	1·9	0·7	0·9
2	Re-sulphured ..	9·8	3·3	7·3	2·5
	Not re-sulphured ..	8·2	4·0	3·4	2·9

(NOTE.—All figures are in grains per lb.)

On arrival, the moisture content of the London samples averaged 20 per cent., the Melbourne samples 18 per cent. There is a very considerable and irregular loss in SO_2, which appears to be greater in the case of the London samples.

In a similar larger scale experiment, bulk samples were sent to London and returned while similar samples were retained in sealed containers in Merbein.

TABLE 9.

Treatment.	London samples.			Merbein samples.	
	SO_2 content.	Quality (Colour).	Moisture Content.	SO_2 content.	Quality.
	grains/lb.			grains/lb.	
1. Moistened to 20% moisture 8 grs./lb. SO_2	1·3	3	21·0	1·0	3¼
2. As in 1, but re-sulphuring 11 grs./lb. SO_2 ..	2·4	3½	23·5	4·9	3½
3. Control untreated 11% moisture 12 grs./lb. SO_2	..	..	..	2·6	4

Further samples containing 8 to 14 grains of SO_2 per lb. were stored at an approximate moisture content of 20 per cent. and, on later examination, it was found that at least 10 grs. per lb. at the outset were necessary in order to retain a suitable colour. In these tests, the apricots were moistened by short immersion in water at a temperature of approximately 180 deg. F. In general, re-sulphuring resulted in the production of a slightly brighter fruit. In considering these tests, it has been borne in mind that they are very severe, involving two sea voyages and an eight months' storage. Normally, Australian fruit is disposed of within a few months.

Various methods of re-processing for a moist pack have been employed. Steaming in special chambers is the standard method when re-sulphuring is employed. Immersion in hot water at 180 deg. F. is also practised. Another method employed is to treat the fruit with a cold 3 per cent. paraffin emulsion in a washing machine; this increases the moisture content, and also tends to assure a high degree of immunity from later infestation of dried fruit pests.

The Effect of a Soil Mulch on Soil Temperature.

*By E. S. West, B.Sc., M.S.**

In a previous issue of this *Journal* (Vol. 3, p. 97, 1930), Mr. West discussed the effect of a soil mulch on the quantity of water lost from a given soil by evaporation. The report that follows is somewhat complementary to that discussion, and it is accordingly printed below.—Ed.

Summary.

The loose layer of soil at the surface caused by cultivation has a lower heat diffusivity than the compact soil. In the case investigated, it is deduced that the heat diffusivity was reduced to 0.17 of that of the original compact soil. This results in the soil temperature wave of cultivated soil being markedly damped, when compared with that of the uncultivated soil for any particular depth below the cultivated layer. In the cultivated layer itself, the temperature wave at the surface has a greater amplitude than the temperature wave at the surface of undisturbed soil, but at the bottom of the cultivated layer the amplitude is much less in the cultivated soil than at a similar depth in the uncultivated soil. The mean temperature during the summer months, down to a depth of 60 cms., was about 2° C. cooler in the cultivated soil than in the undisturbed soil.

1. Introduction.

It is to be expected that a soil mulch, that is, a loosely cultivated surface layer of soil, should have some effect on the soil temperature, as soil in a loose condition is obviously a poorer conductor of heat than compact soil.

The phenomenon of the conduction of heat through soil was investigated by Patten†; Keen and Russell‡ investigated the trend of the soil temperature at Rothamsted at 6 inches deep, and its relation and dependence on sunshine, wind, and other weather factors; and Taylor§, working in Egypt, investigated the daily and seasonal temperature wave at different depths and the relation between the waves at various depths.

The question of the effect of cultivation on the soil temperature, though of obvious importance, particularly under such conditions as the bare fallow of the Australian wheat farm, and in clean cultivated orchards, does not seem to have been investigated before, so that records have been kept at the Commonwealth Research Station, Griffith, of the soil temperature at different depths, both in cultivated and uncultivated soil, weed growth being prevented in both cases.

2. Experimental Procedure.

Two adjacent plots on uncultivated, undisturbed land, each 18 feet x 9 feet, were marked out. Thermometers were placed at depths 15 cms., 30 cms., and 60 cms. at each end of each plot, in positions 4½ feet from the ends and sides of the plots. The bulbs of a two-bulb Negretti and

* Officer-in-charge, Commonwealth Research Station, Griffith.

† Patten, H. E. "Heat Transference in Soils." U.S.D.A. Bur. Soils, Bull. 59 (1909).

‡ Keen, B. A., and Russell, E. J. "The Factors Influencing Soil Temperature." *Jour. Agric. Sci.* **11**: 212–239, 1921.

§ Taylor, E. M. "Soil Temperatures in Egypt." *Jour. Agric. Sci.* **18**: 90–122, 1928.

Zambra soil thermograph were also placed, one in the centre of each plot, at a depth of 15 cms., and the bulbs of a second similar instrument were placed at 30 cms. in the centre of each plot.

The thermometers were ordinary chemical mercury instruments about 17 cms. long, graduated from 0° C. to 60° C. in wide graduations, the 1° graduation being about 3 mms. long. This meant that the mercury column was rather sluggish, which was an advantage, as it prevented undue alteration while reading. In placing the thermometers in position, a hole was driven into the soil with an iron rod. The bottom part of the hole was formed by the use of a rod of smaller diameter and shaped at the end to the same shape as that of the thermometer. When placed in position, the bulb of the thermometer, therefore, fitted snugly into the soil. A casing of glass tube was then placed in the upper part of the hole to prevent soil falling into it. In the case of the 30 cms. and 60 cms. depths, glass rods were attached to the end of the thermometers by means of rubber tubing, to permit the ends and sides of the plots. The bulbs of a two-bulb Negritti and of the lowering of the thermometers to the correct depths. As the bulbs of the thermometers are about 15-17 mms. long, the holes were made of such depths that the centre of the bulb corresponded with the depths desired. The thermometers were read by quickly raising them until the mercury column was visible and noting its position. Readings were taken to 1-10th of a degree.

The 15 and 30 cms. thermometers were read twice daily at the times of the maxima and minima temperatures, but as the temperature wave at 60 cms. is so small, the temperature at that depth was read only once a day, at 9 a.m. The maximum temperature for any depth occurs at a definite time after the sun is in the meridian, and occurs at 6 p.m. for the 15 cms. and 10 p.m. for the 30 cms. The times of the minima temperatures depend on the time of sunrise and so varies throughout the year.* The time for each depth can be readily determined by the time of sunrise, but it was found more convenient to observe the time from the thermograph for the 15 and 30 cms. depths.

The plots were set up in June, 1929, and allowed to remain undisturbed until 22nd August, 1929, in order to allow them to settle down under the influence of the weather. The temperatures, however, were recorded. One plot was then carefully dug to a depth of 10 cms., and a fine mellow mulch was maintained thereafter. This caused the surface to rise 3 cms. Datum pegs had previously been put in, so that the original levels of both plots could be referred to, if desired.† After rains, the soil of the cultivated plot was stirred to maintain the mulch. Weed seedlings were plucked from the uncultivated plot as soon as they appeared. In the case of the cultivated plot, the stirring of the soil after heavy rains kept down the weeds.

3. Discussion of Results.

Figs. 1 and 2 show typical soil temperatures for the 15 cms. and 30 cms. depths, respectively. It is to be noted that the wave in the cultivated plot has a slight lag and is greatly damped, compared with that in the uncultivated plot.

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* Taylor, E. M., loc. cit.

† It is to be understood that the depth in the mulch plots refers to the depth from the original surface level before cultivation and not the depth from the new surface level.

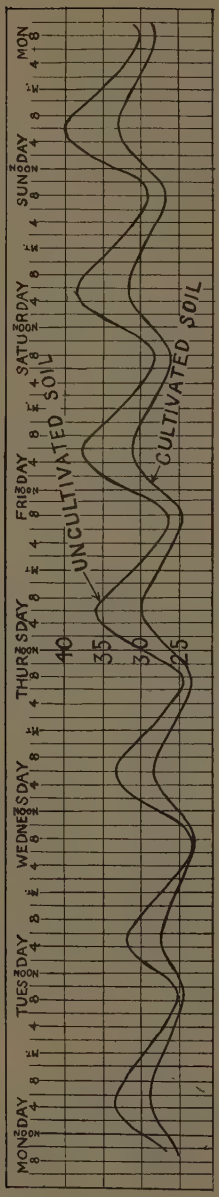

FIG. 1.—Soil temperatures 15 centimetres deep.

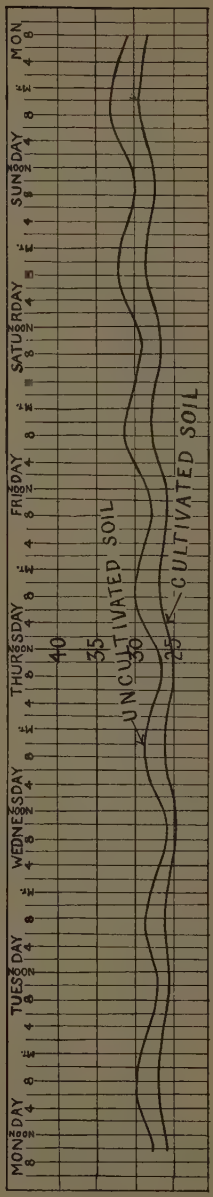

FIG. 2.—Soil temperatures 30 centimetres deep.

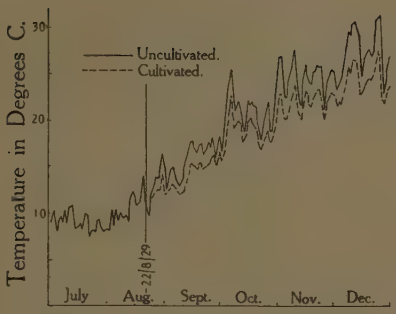

FIG. 3.—Daily mean soil temperatures at 15 centimetres.

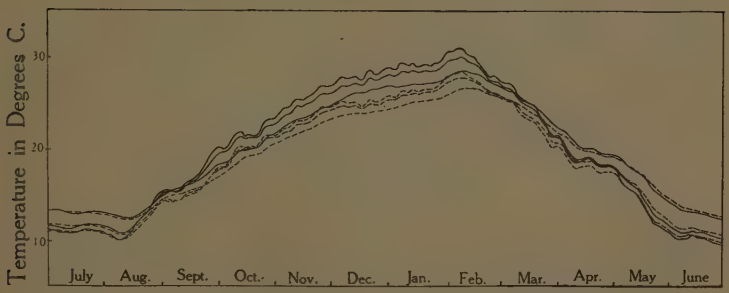

FIG. 4.—Smoothed curves showing trends of mean soil temperatures from 1st July, 1930, to 30th June, 1931.

The mean daily temperature* recorded by each thermometer was plotted throughout the period of the experiment. At all times, the graphs of the duplicates ran close together, though those for the different depths and in the cultivated and uncultivated soils diverged. The mean daily temperatures determined by the thermometers also accorded with the data obtained from the thermographs, so that the data submitted can be taken as an accurate record.

Fig. 3 shows the mean daily temperatures for 15 cms. depth for both the cultivated and uncultivated plots, for a period in the spring. The excessive fluctuations which rather obscure some of the properties of these curves are smoothed out in Fig. 4, which shows smoothed curves for a typical twelve-month period.† In Fig. 4, the ordinate for each day is the mean temperature for the three-week period, of which that day is the median. That is, to obtain the ordinate for the smoothed curve for the 15 cms. of the mulch plots for 11th March, the arithmetric mean of the mean temperatures for each day of the period from 1st to 21st March inclusive was found. Each daily mean is the mean of the mean temperatures determined from the two chemical thermometers and the thermograph, so that, 21 x 3 x (max. + min.) = 126 readings are used in obtaining each ordinate in Fig. 4.

Considering, first of all, the graphs for the uncultivated plot, all the well-known features of the seasonal temperature wave are readily recognized, namely, the increasing temperature gradient with depth in the winter, the decreasing gradient in summer, and the crossing over of the graphs in March and late August, when the mean daily temperatures at these depths are uniform. The damping out and lag of the lesser fluctuations in temperature with depth is also evident.

Considering the effect of the soil mulch on the trend of the soil temperature, it is seen from Fig. 3 that, immediately after the soil mulch was made on 22nd August, the soil began to warm up more quickly in the uncultivated soil than in the cultivated soil at the three depths recorded, so that, during the summer months, the temperature at the 15 cms. depth is usually about 3° C. warmer in the uncultivated soil than in the cultivated soil, and even at the 60 cms. depth, the uncultivated soil is about 2° C. warmer than the cultivated soil. During the cool changes in the summer, the differences in temperature are inclined to be a little less, due to more rapid cooling of the uncultivated soil. In the autumn, the uncultivated soil cools more rapidly than the cultivated soil, so that, in the beginning of the winter, i.e., about May or June, the temperatures are the same in both cultivated and uncultivated soils. During the winter, there is a tendency for the temperature on the cultivated soil to fall below that of the uncultivated soil, but this tendency is largely obliterated by the winter rains. The effect of heavy rains is to cool the surface layers of the soil, and, at the same time, to bring the cultivated and uncultivated soils to approximately the same temperature. As the capacity for heat of the water retained by soil after a heavy rain is two or three times as great as that of the dry soil, the comparatively small differences in temperature of the cultivated and uncultivated soils are largely swamped out. The large cooling effect of the evaporation of water from the surface after the rain

* The arithmetric mean of the maximum and minimum daily temperature is taken as the daily mean temperature. Actual calculations from the thermograph records for both the 15 and 30 cms. depths showed that this was in fact a very close approximation of the true daily mean.

† Data are available for a period of three years, but those for the other two years are similar in all essential details to those for this twelve-month period.

would also tend to swamp the original differences in temperature. For the three years, the mean temperatures for the three summer months, namely, December, January, and February, were as follows:—

——	Uncultivated Soil.	Cultivated Soil.
Depth 15 cms.	30.10° C.	27.31° C.
„ 30 cms.	29.17° C.	26.92° C.
„ 60 cms.	27.73° C.	25.85° C.

Similar data for the six months, October-March inclusive, were—

——	Uncultivated Soil.	Cultivated Soil.
Depth 15 cms.	27.23° C.	24.81° C.
„ 30 cms.	26.42° C.	24.53° C.
„ 60 cms.	25.58° C.	23.77° C.

As there is such a marked difference in the soil temperature at the depth of 60 cms., it is quite obvious that cultivation must have a big effect on the soil temperature to much greater depths, in fact, it appears evident that the temperature to the total depth of soil of chief agricultural interest, i.e., the depth to which the greater proportion of the roots of most plants penetrate, is appreciably affected by the loose layer of soil created by cultivation. Whether this is an advantage, or otherwise, to plants, probably depends upon the type of plant grown, as the maximum daily temperature at 15 cms. seldom rises about 40° C., even in the uncultivated soil, which is about the optimum soil temperature for many summer growing plants. It is improbable, however, that the soil temperature effect of cultivation would have an appreciable direct effect on the plant.

In order to examine, in more detail, the insulating effect of the mulch, a further set of thermometers was set up in two plots, immediately adjacent to the original plots. One plot was stirred to a depth of 10 cms. and a line of thermometers was placed in each plot, 5 cms. apart and every 2 cms. in depth in the uncultivated from 2 to 24 cms., and in the cultivated soil from 0 to 22 cms.* Readings were taken every two hours from 6 a.m., 24th February, 1932, to 10 p.m., 25th February, 1932, the thermometers having been set up a day or two before this period. When placed in position, the mercury column was visible in the thermometers to the 12 cms. depth, so that these were placed in position without a glass casing. In the case of the lower depths, a glass casing was used near the surface.

As the bulbs of the thermometers are 2 cms. long, the reading of the thermometers placed at any particular depth. for example, 10 cms., is actually due to a kind of mean temperature for the depth 9-11 cms. rather than the temperature at the 10 cms. point, but for the purpose of the following comparison this would not seem to affect the issue.

Figs. 5 and 6 show the series of temperature waves obtained by plotting the temperature against the time for each depth, in the uncultivated and cultivated plots, respectively. A comparison of these figures

* As the surface of the cultivated soil rose 3 cms. in height, the thermometer at depth 0 cms. though 10 cms. above the undisturbed soil, was 3 cms. below the new surface of the stirred soil.

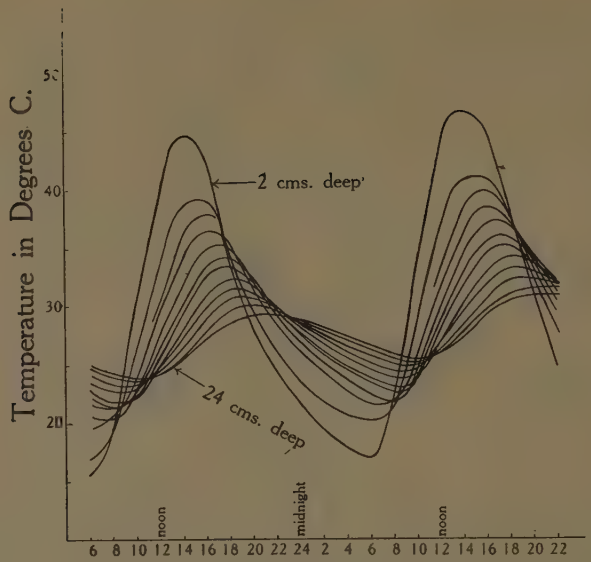

FIG. 5.—Temperature-time curves for different depths in uncultivated soil.

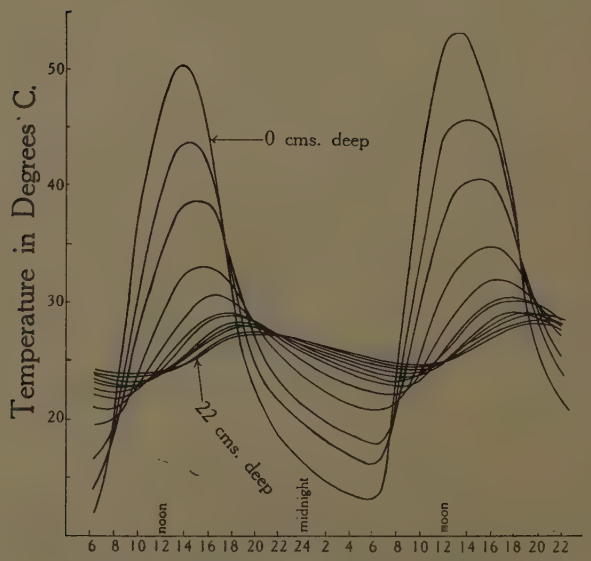

FIG. 6.—Temperature-time curves for different depths in cultivated soil.

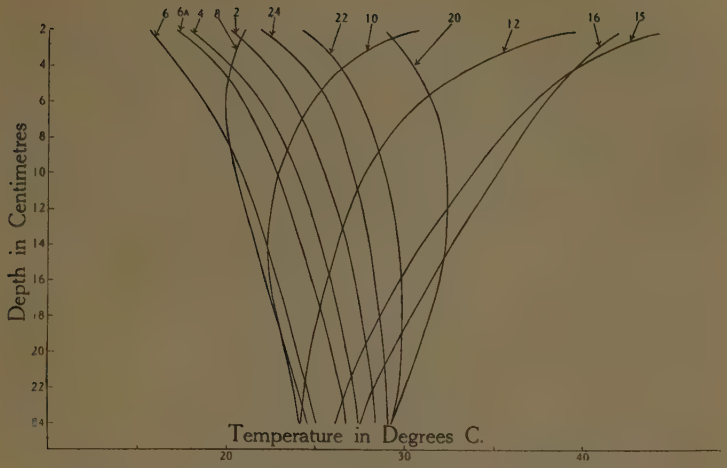

FIG. 7.—Temperature-depth curves from 6 a.m., 24th February, 1932 (6), to 6 a.m., 25th February, 1932 (6A), in uncultivated soil.

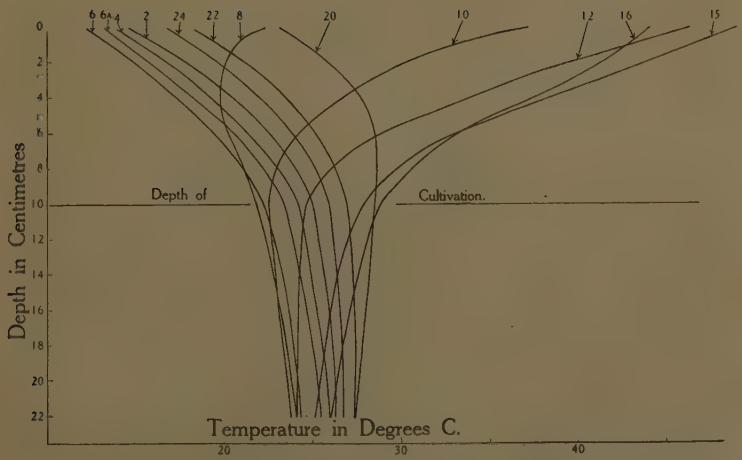

FIG. 8.—Temperature-depth curves from 6 a.m., 24th February, 1932 (6), to 6 a.m., 25th February, 1932 (6A), in cultivated soil.

at once shows that the diurnal temperature wave at the surface of the cultivated soil has a much bigger amplitude than that of the uncultivated soil. That is, that the surface of the cultivated soil gets warmer during the day and colder during the night than that of the uncultivated soil.† However, owing to the difference in heat diffusivity of the cultivated layer to that of the compact soil, the wave is damped out with depth much more quickly, as illustrated by the bigger spaces between successive maxima and minima in the first 10 cms. of cultivated soil. As a result of this, the wave at the 10 cms. depth (bottom of mulch) has a much smaller amplitude than that at the same depth in the uncultivated soil. The loose mulch has a lower diffusivity of heat than the compact soil, so that, on warming up the surface, heat moves down more slowly when the surface is cultivated, and the surface, therefore, becomes warmer than is the case in compact soil. During the night, heat moves more slowly to the surface from below to replace heat lost by radiation, so that, the surface cools more on the cultivated soil than on the uncultivated soil. However, due to the lower diffusivity of the soil, the wave is damped out much more quickly when the surface is cultivated. These relationships are made evident in considering the ratio of the amplitudes of the successive temperature waves as in Table 1.

TABLE 1, SHOWING THE RATIO $\frac{\text{AMPLITUDE AT DEPTH } x \text{ CMS.}}{\text{AMPLITUDE AT DEPTH } x + 2 \text{ CMS.}}$

For Uncultivated and Cultivated Plots.

Depth in Centimetres.	Uncultivated.			Cultivated.		
	Amplitude.	Ratio.	Mean Ratio.	Amplitude.	Ratio.	Mean Ratio.
0	..	..	..	36·6		
					0·76	
2	27·6			28·0		
		0·70*			0·73	
4	19·2			20·5		
		0·86			0·61	0·71
6	16·6		0·87	12·4		
		0·90			0·71	
8	15·0			8·7		
		0·86			0·73	
10	12·9			6·4		
		0·88			0·89	
12	11·4			5·7		
		0·89			0·79	
14	10·2			4·5		
		0·81			0·89	
16	8·4			4·0		0·87
		0·81	0·83		0·90	
18	6·8			3·6		
		0·81			0·86	
20	5·5			3·1		
		0·87			0·87	
22	4·8			2·7		
		0·77				
24	3·7					

NOTE.—* The thermometer at 2 cms. depth was so close to the surface that the bulb was almost visible. Probably the mercury was partly heated and cooled by direct radiation, which caused an exaggerated amplitude for the 2 cms. wave (Fig. 5), which would tend somewhat to depress this ratio.

† This is manifest in frosty weather when it will be observed that frost appears on cultivated land before it appears on bare, uncultivated soil.

If the soil were uniform with respect to conductivity and specific heat throughout its depth, these ratios should be constant. It is to be seen that the ratios in the uncultivated plot and undisturbed soil of the cultivated plot are approximately constant at 0.85. In the case of the cultivated portion, however, the ratio is approximately constant at 0.71, which means that the diffusivity, i.e., the ratio "conductivity divided by specific heat" is less in the cultivated portion. From these ratios, it is possible to obtain some idea of the influence that the cultivation had on the diffusivity of the surface 10 cms. of this soil:—

Consider the two equations:—

$$k = \frac{\lambda^2}{4\pi\tau}$$

and

$$\frac{\theta_2}{\theta_1} = e^{\frac{-2\pi(x_2 - x_1)}{\lambda}}*$$

where k = the diffusivity

$\frac{\theta_2}{\theta_1}$ = the ratio of the amplitudes of the temperature waves at depths x_1 and x_2.

τ = time period of temperature wave

λ = wave length.

Combining the two equations

$$\log \frac{\theta_1}{\theta_2} = -(x_2 - x_1)\sqrt{\frac{\pi}{\tau k}}$$

putting $\log \frac{\theta_1}{\theta_2} = r$

then $k_m = k_c \frac{r_c^2}{r_m^2}$

where the subscripts c and m refer to the compact and cultivated (mulch) soils, respectively.

Using the figures obtained above for the ratios, viz., 0.87 for that of the compact soil and 0.71 for that of the cultivated soil, it appears that the diffusivity of the cultivated soil is 0.17 times that of the compact soil.

The effects of the cultivated layer are well brought out in Figs. 7 and 8, which show the temperature-depth curves for different times in both the uncultivated and cultivated soils. These series of curves may be considered to sweep from one extreme position at the time 6 o'clock to the other extreme position at 15 o'clock† and then back again, but during the morning, as at 8 a.m., the soil is still cooling at the lower depths, while warming near the surface, as is evident from the positions of the 6 and 8 o'clock curves, while during the afternoon the soil is cooling near the surface and still warming up below, as is evident from the 15 and 16 o'clock curves. It may be noted that when two curves representing consecutive time intervals cross, it represents a maximum

* Keen, B. A. "The Physical Properties of the Soil." Longman, Green, and Co., pp. 310–311 (1931).

† Actually, the maxima at the surface occurred at 2 p.m. = 14 o'clock, but, unfortunately, this reading was missed. It is seen that the curve 15 o'clock has already begun to sweep back.

in the temperature wave at that depth (Figs. 5 and 6), if the curve representing the later time crosses the other from left to right going down, and a minimum if it crosses from right to left going down.

Where the temperature depth curves are vertical it means that the temperatures are uniform at these depths at this time, as in the 12 o'clock curve (Fig. 8) from depths 12 to 22 cms. (see also the curves for these depths at 12 o'clock in Fig. 6). The distance between the extreme curves at any particular depth shows the amplitude of the soil temperature wave at that depth, and the slope of curves at any depth shows the temperature gradient at that depth and time. Keeping this in mind, the effect of the stirring of the soils is at once evident, by comparing Figs. 7 and 8. The amplitude of the temperature wave is greater at the surface of the cultivated soil than that of the uncultivated soil, but the temperature gradients at the times of the minimum and maximum surface temperatures are much steeper in the cultivated soil than in the uncultivated soil, so that, at the depth of 10 cms. (depth of cultivation) the amplitude is much smaller in the cultivated soil than that in the uncultivated soil. The curves in Fig. 8 consist of two portions, that above the 10 cms. depth (depth of cultivation), where the slopes are greatest, and that below the 10 cms. depth, where the slopes are small. Breaks in the curves occur at the 10 cms. depth.

4. Conclusion.

In this experiment, the temperatures in a bare undisturbed soil are compared with those in a cultivated soil. Where vegetation is allowed to grow, the conditions would be different, and the effects would largely depend upon the type of vegetation, whether green or dry, abundant or sparse, &c., but in general one would expect the same type of effect as with the cultivated layer of soil, viz., the damping of the daily and seasonal wave, causing a lower summer soil temperature, compared with that of the bare undisturbed soil.

Radio Research Board: Fourth Annual Report (for Year ended 30th June, 1932).

The Radio Research Board of the Council is constituted:—Professor J. P. Madsen (University of Sydney), Chairman; Mr. H. P. Brown (Director-General, Postmaster-General's Department); Electrical-Commander F. G. Creswell (Department of Defence); and Professor T. H. Laby (University of Melbourne). Its previous annual report was published in this *Journal* (Vol. 4, No. 4, November, 1931).—Ed.

1. General.

Throughout the period under review, the work of the Board has been concentrated on two main lines, namely:—(i) fading and Heaviside Layer work, and (ii) atmospherics.

The staff of the Board has declined still further, Dr. L. G. H. Huxley resigning in September, 1931. This loss of staff, however, has been offset by the services of two University research workers being kindly made available to the Board by the co-operation of the authorities concerned. These students are Mr. H. B. Wood, of the University of Sydney, and Mr. W. J. Wark, of the University of Melbourne. Towards the close of the year, Professor Madsen and his staff were able to complete the erection of an experimental emitting station in the P. N. Russell Engineering School of the University of Sydney. The transmitter is capable of delivering a power of approximately 1,000 watts into the aerial, and has been specially designed for the fading and Heaviside Layer work of the Board.

2. Work on Fading and the Heaviside Layer.

Throughout the period under review, the studies of fading and the Heaviside Layer have been continued in Victoria and in New South Wales.

In the previous report, it was mentioned that some work was in progress on the method proposed by Dr. Martyn for estimating the height of the Heaviside Layer at various times and under various atmospheric conditions. For various reasons, progress has been delayed, but the investigations are now being continued.

The classification of the different types of fading that occur naturally is obviously of considerable importance from the point of view of the systematic development of means of mitigating the troublesome effects of the phenomenon in question. Work of this nature done to date has resulted in a considerable amount of information regarding conditions of radio reception in Australia. Much of this information is contained in the Board's Report No. 4 (published as the Council's Bulletin 63). In Victoria, many observations have been made at distances up to 200 kilometres from the emitting stations (generally 3LO and 3AR), and some at much greater distances, the emitting stations in these cases being located at Sydney, and the observations being made at Gembrook (Vic.).

The apparatus used for observations on the Victorian stations consisted of a simple type of valve voltmeter, and a continuous photographic recorder. Observations were made simultaneously on two separate aerial systems, one a loop aerial, and the other a vertical aerial. It was found possible to separate the two aerials by 20 or 30 feet without affecting the identity of the signal picked up. This greatly simplified the technique, since the separation was sufficient to prevent electromagnetic coupling.

Observations at distances of 500 to 1,000 kilometres from the transmitting station have shown that two types of fading occur, namely: (i) slow fading of a regular period ranging from two to thirty minutes; and (ii) quick fading superposed on the slow fading, and of smaller amplitude, but of more regular period.

The results of the observations at distances up to 200 kilometres from the emitting station showed that fading was not entirely erratic in character. Three types of regularity were found:—

(*a*) Slow fading of period one to five minutes, and having an amplitude such that the signal intensity ranged from less than half the steady day value to almost double that value.

(*b*) Quick fading of period five to thirty seconds, and of amplitude less than half that of slow fading.

(*c*) Periodic fading, which appears most often in the period from one or two hours after sunset, is of remarkably pure sinoidal form, and has a larger amplitude than quick fading.

Slow fading was found to be due to interference between the ground ray and a ray reflected from the lower Heaviside Layer. Quick fading was attributed to similar interference produced by the upper ionized layer, while the mechanism of periodic fading could not be analysed further than the fact that it was a lower layer phenomenon. In many cases, however, particularly at the nearer receiving sites, it was found that anomalous results were obtained. In these cases, the fading was not in phase on the two aerial systems. Moreover, it was repeatedly found that the height of the Heaviside Layer, as deduced from the angle of incidence of the down-coming wave, was definitely lower than that obtained by other methods of measurement, such as the Appleton frequency-change method. Only two possible explanations of these anomalies could be found, namely:—(i) imperfect conductivity of the ground, and (ii) lateral deviation of the sky wave, i.e., propagation on a plane other than the vertical plane through transmitter and receiver. Experiments were conducted over sea water, which has a considerably higher conductivity than soil, but the anomalies still persisted. It was, therefore, concluded by a process of elimination that there existed a considerable amount of lateral deviation of the sky wave.

Hitherto, it has been assumed by those investigating their propagation, that radio waves on broadcast frequencies are not deviated laterally, but the evidence on which this assumption is based is far from conclusive. Moreover, the theoretical work of Dr. W. G. Baker, whilst he was a member of the staff of the Radio Research Board, suggests that the asymmetry introduced by the earth's magnetic field might well be responsible for a lateral deviation of sky waves.

A method depending on the taking of simultaneous observations of natural fading on three aerial systems was accordingly developed to measure, among other things, this lateral deviation. As a result, clear evidence of the lateral deviation of the sky wave has been found. The method has been adapted to the frequency-change technique of Appleton, thus rendering it possible for observations to be made on all the constants of the down-coming ray, including its lateral deviation, irrespective of the degree of turbulence of the Heaviside Layer itself. This work will be undertaken, using the new experimental emitting station at the Sydney University.

Studies of the heights of the Heaviside Layer at various times, and of the polarization of sky waves after reflection from the Layer, have been continued. The results of this work, which was carried out mainly at Jervis Bay, have been published as the Board's Reports Nos. 2 and 3 (issued as the Council's Bulletins 59 and 60 respectively). It was found that the polarization of the down-coming rays at the time of observation—which was necessarily near sunrise—was fairly constant. This suggested—an assumption which was also to a certain extent supported by theoretical considerations—that such a condition of polarization might hold for other periods of the day or night, in which case it would be possible to control fading at moderate distances from the transmitter by balancing the abnormal component of the down-coming ray against the normal. Trials carried out at Liverpool, however, indicated that such conditions did not hold, and it was realized that the state of polarization of the down-coming rays at different times of the day required further investigation.

This work required a special technique, the development of which has been considerably helped by the fact that the studies of fading in Victoria have shown that the necessary different types of aerials could be used at the receiving site, provided they were suitably spaced. A method has accordingly been developed involving simultaneous observations on three different aerials at Liverpool. Special attention has been given to the sky wave and to its reception on different types of aerials. Already various novel properties of different types of aerials have been noted. For example, a short horizontal antenna was found to have marked directional properties, being rather better in this respect than a loop aerial.

3. Work on Atmospherics.

(i) *Equipment.*—In last year's report, a description was given of the method of observing atmospherics using two cathode-ray direction-finders, one located at Mt. Stromlo, near Canberra, and the other at Laverton, near Melbourne, the base line being approximately 300 miles. The two observers are able to communicate with short-wave remote-controlled transmitters working on 43 metres, so that directions of individual atmospherics can be observed simultaneously at the two stations, and their origins located by plotting the bearings. The work on those instruments has been carried out on wavelengths between 3,000 and 30,000 metres, but mainly on 3,000 metres, and mostly by day. In most cases, the intensities as well as the directions of the atmospherics have been observed.

Early in the present year, a new type of cathode-ray oscillograph (designed by von Ardenne) was installed at the Laverton station. Owing to its better focussing and brighter spot, more accurate observations of sizes and directions of atmospherics and of their characteristics can be obtained. Another such tube is being used at Laverton on an auxiliary receiver to give the intensities on 300 metres, or thereabouts, of atmospherics observed simultaneously on the cathode-ray direction-finder on 30,000 metres.

A continuous directional recorder for atmospherics, which was designed and constructed by the British Radio Research Board, has been in use at the Mt. Stromlo station for a year. This instrument uses a rotating loop aerial system, and the signals after amplification activate an oscillograph. The end of the oscillograph pointer carries a siphon pen which records on a paper chart on a rotating drum, and the arrangement of the amplifiers is such that each atmospheric received produces a vertical upward kick of the pen.

(ii) *Results.*—It was stated in last year's report that all the atmospherics observed appeared to be due to lightning strokes generally occurring in thunderstorms, and that atmospherics appeared to have much the same size at their origin, so that variations in the observed intensities were due mainly to attenuation in the paths. In other words, if we regard each atmospheric as being produced by a natural transmitter, then all these transmitters operate with the same order of power. These conclusions have been confirmed by all the more recent work.

The average intensity of a source of atmospherics has been taken as the mean of a number of typical individual atmospherics in it, and when these mean intensities on 3,000 metres for a number of sources are plotted against the distance of the corresponding sources as located by the direction-finders, the points are found to lie closely along a mean curve representing the variation of intensity with distance from 50 to 1,500 miles. The most marked deviations from the curves are for those cases in which the transmission path is (i) over heavily-wooded ranges and the attenuation is exceptionally great, and (ii) over sea, where, as would be expected, the attenuation is least.

The observations have indicated that for a given atmospheric, the intensity observed on a receiver of given low-frequency response is to a first approximation proportional to the wavelength to which the receiver is tuned. In addition to this, the attenuation is much greater on short wavelengths than on long. This would mean that, other conditions being equal, the longer the wavelength to which a receiver is tuned the more the interference from atmospherics. As mentioned previously, however, observations are now in progress to extend the knowledge of the intensities to the shorter wavelengths of the broadcast band using an auxiliary receiver on 300 metres.

A year's charts from the recorder have been analyzed and considered in conjunction with (i) the cathode-ray direction-finder observations, (ii) meteorological reports, particularly of thunderstorms in and near Australia, and (iii) Brooks's charts of the distribution of thunderstorms over the earth.

The use of the cathode-ray direction-finder observations on shorter wavelengths down to 3,000 metres has enabled the nearer sources to be distinguished from the distant ones. It has been found that the sources fall into two fairly distinct types:—(i) *regular,* which occur in the same direction at the same time almost every day over several months of the year; and (ii) *irregular,* which show no marked period of recurrence in either direction, time, or duration.

The combined evidence of direction, diurnal variation, and seasonal variation, and of observations of close sources, establishes quite decisively that the regular sources are in the tropical areas of great thunderstorm activity.

In the local summer months, September to March, one of these very active areas exists in the north of Australia, so that it has been possible to observe with the direction-finders the sources (i.e., the most active centres) there, and to record the intensities and frequency of occurrence of atmospherics in such sources, the latter being generally at least 60 per minute, giving an almost continuous disturbance in a receiver. This area is naturally the most serious as regards interference with radio reception in Australia. The area includes New Guinea and Java and the surrounding islands, and is active during the afternoon and evening, the maximum of activity moving westward with the sun. The other main source during this season is in tropical Africa south of the Equator. This is the most intense thunderstorm area in the world.

From April to October, there is little day-time activity to the north, but a fairly strong evening source in the direction of the Malay Archipelago and southern Asia. The night source from Africa is very prominent, but it has now moved to mainly north of the Equator. A further source becomes apparent just before dawn in the direction of Central Europe and Central America (great circle). Considerations of time and thunderstorm activity suggest that this is probably mainly from the American area, the atmospherics taking the longer night path. This source is no longer apparent after sunrise, probably owing to unfavorable transmission conditions.

The irregular sources again fall into two main classes:—(i) Distant sources in directions between N' and E, probably due to thunderstorms over the tropical ocean and islands; and (ii) sources occurring within or close to Australia in sub-tropical latitudes and associated with areas of low barometric pressure. The frequency of occurrence in this last type of source is much less than for the regular ones (partly, but not wholly, due to the smaller area) being generally less than 30 per minute, and may be as low as one or two in five minutes for depressions over the sea to the south.

The sources in the Tasman Sea are particularly reliable as indications of weather conditions, for practically every depression in this region in lats. north of 40° S. has atmospherics associated with it by day. In the Australian Bight, the atmospherics from depressions of equal intensity are fewer than in the Tasman, but they give useful indications of the presence of depressions which are too far south for observations by land stations or ships, so enabling more accurate forecasting of weather in Victoria and Tasmania.

All the evidence obtained as a result of the investigations to date supports the belief that, with a few suitably located cathode-ray direction-finders, low-pressure areas could be traced as they approached Australia from the Indian Ocean and the Australian Bight, and in that way considerably earlier information obtained as to their existence than is possible by existing methods depending on barometric readings from land stations and one or two ships at sea.

4. Publications.

The following publications have been made during the past year as a result of the Board's investigations:—

Bulletin 59.—Radio Research Board: Report No. 2.

1. The State of Polarization of Sky Waves, by A. L. Green, M.Sc.
2. Height Measurements of the Heaviside Layer in the Early Morning, by A. L. Green, M.Sc.

Bulletin 60.—Radio Research Board: Report No. 3.

1. The Influence of the Earth's Magnetic Field on the Polarization of Sky Waves, by W. G. Baker, B.E., D.Sc., and A. L. Green, M.Sc.

Bulletin 63.—Radio Research Board: Report No. 4.

1. A Preliminary Investigation of Fading in New South Wales, by A. L. Green, M.Sc., and W. G. Baker, B.E., D.Sc.
2. Studies of Fading in Victoria. A Preliminary Study of Fading on Medium Wavelengths at Short Distances, by R. O. Cherry, M.Sc., and D. F. Martyn, Ph.D., A.R.C.Sc.
3. Studies of Fading in Victoria: Observations on Distant Stations in which no Ground Wave is received, by R. O. Cherry, M.Sc.

At the present time, the following Bulletin is in the press:—

Bulletin No. 68.—Radio Research Board: Report No. 5.

Atmospherics in Australia: I. By G. H. Munro, M.Sc., A.M.I.E.E., and L. G. H. Huxley, M.A., D.Phil.

Several other reports are in preparation.

5. Acknowledgments.

Once again, acknowledgment is due to a number of organizations and individuals for the valuable co-operation they have furnished. The help of the Postmaster-General's Department and the Universities of Melbourne and Sydney has been continued on the previous lines. The Department of Defence has afforded valuable assistance in several ways, but notably by the loan of apparatus and the accommodation of equipment at Laverton (Victoria) and Liverpool (New South Wales). The Commonwealth Solar Observatory at Mt. Stromlo and the Watheroo Magnetic Observatory of the Carnegie Institution are also co-operating most helpfully in connexion with the work on atmospherics.

Buffalo Fly Investigations.

A Note on the Occurrence of *Hydrotaea australis* Malloch in Northern Australia.

By I. M. Mackerras, B.Sc., M.B., Ch. M., Division of Economic Entomology.

Muscid flies of the genus *Hydrotaea* are harmless as adults. Their larvae live in dung and are predatory on other Dipterous larvae. It is natural, therefore, that the use of these flies should be seriously considered in attempts to control such pests of stock as the stable fly, the horn fly, and the buffalo fly, all of which breed in cattle or buffalo dung. In 1928, and with this end in view, the Council obtained a consignment of *Hydrotaea dentipes* Fabr. from the Imperial Institute of Entomology. However, owing to inability to breed this species in captivity, permission to liberate was not requested, and the consignment was ultimately destroyed by Mr. G. F. Hill, who was in charge of the investigation.

Two Australian species of *Hydrotaea* have been described, *H. fuscocalyptrata* Macq. and *H. australis* Malloch.* Nothing was known of these beyond the original descriptions, and it was considered necessary that some knowledge of their habits, life-histories, and distribution should be obtained before undertaking further introductions of predatory flies. The present paper gives an outline of our present knowledge of *H. australis* Mall. More detailed accounts of the life history and biology of this insect will be published at a later date. *H. fuscocalyptrata* has not been recognized in recent collections.

Hydrotaea australis Mall. is a small, inconspicuous, dark-grey fly, which superficially rather closely resembles both *Fannia australis* Mall. and *Antipodomyia bancrofti* Mall., with both of which it has been confused in the past. The males are recognized by the presence of two strong spines near the apex of the fore femur, and the females by the presence of a pair of cruciate bristles in the middle of the frons. In addition, *F. australis* is slightly larger and darker, while *A. bancrofti* is more conspicuously marked with pale grey.

Adults are found commonly on horses and cattle, apparently feeding on the sweat and "scurf." On cattle, they have frequently been mistaken for buffalo flies. They were a source of considerable difficulty during a survey of the distribution of the buffalo fly in North Queensland, as it was necessary to throw the cattle or run them into a crush, in order to be certain of the identity of the flies. On the beast, they rest more horizontally than *Lyperosia*, their wings are not so iridescent and are held at a different angle, and the acute observer can usually detect the difference in the proboscis, which in *Hydrotaea* is of the normal Muscid form. They cause no obvious inconvenience to the host.

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* *Ann. Mag. Nat. Hist.* (9), xi., t67, June, 1923.

I have long been convinced that inspection of moving cattle is unreliable as a method of preventing the spread of the buffalo fly into clean country. It is difficult enough to detect buffalo flies, when present in small numbers, and the presence of *Hydrotaea* greatly increases the difficulties of the inspector.

The larvae and puparia are not unlike those of *Lyperosia*. They were first obtained in cattle dung at Wyndham, W.A., by Mr. T. G. Campbell, and have since been fund in dung in many localities in northern Australia. They occupy the same stage of dung succession as the larvae of *Lyperosia*. The habit of devouring other larvae has not yet been actually observed in the laboratory, but Mr. H. Willings has reported that, when *Hydrotaea* larvae are present in a mass of dung, the larvae of *Lyperosia* are scarce. A detailed investigation of this point is being undertaken. Puparia of *Hydrotaea* are attacked by the local parasites, *Spalangia orientalis* Graham and *Phaenopria* sp., but apparently not so readily as those of *Lyperosia*. From the available information, it does not appear likely that these parasites exert any appreciable check on *Hydrotaea*.

Hydrotaea australis is widely distributed through the area at present occupied by the buffalo fly, namely, from Wyndham, in Western Australia to the Burketown-Normanton district in North-West Queensland. It also occurs in the area of potential spread of *Lyperosia*. I have bred it from dung at Springsure* and have seen a number of specimens collected and bred from dung by Dr. T. L. Bancroft at Eidsvold, South Queensland. Malloch also records it from Kendall on the North-Coast of New South Wales. In North Australia, it occurs throughout the year, both in the wet and dry seasons. There is insufficient information concerning its seasonal distribution further south, but it appears to be a warm weather species.

There is little doubt that *Hydrotaea australis* is a useful insect, and that it helps to reduce the numbers of adult *Lyperosia*. It is certainly of more use than any of the dung-eating beetles so far discovered, with the possible exception of a small species of Staphylinid, *Oxytelus* sp. Its actual economic value is, however, difficult to determine.

In view of the existence of a well adapted and widely distributed native species of *Hydrotaea*, it hardly seems reasonable to expect that the emergence of adult *Lyperosia* would be appreciably reduced by the introduction of another species of the same genus.

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* Central Queensland.

NOTES.

The Brisbane Food Preservation Research Laboratory.

In a previous issue (Vol. 5, p. 133, 1932), a brief account was given of the programme of work proposed for the above laboratory, which was then in course of erection. The laboratory was formally handed over by the Queensland Meat Industry Board on the 26th July, 1932, and was accepted on behalf of the Commonwealth by the Minister in charge of the Council (Senator the Hon. A. J. McLachlan). The Board has generously provided, not only the necessary buildings, but also the full equipment and facilities, such as power, refrigeration, gas, &c.

The buildings so far erected consist of an office and two research laboratories, and three small refrigerated chambers. This unit, which is self-contained, has been built on the seventh floor of the main block of the abattoir, and is close to the main slaughter floor from which supplies of meat for experimental purposes will be drawn.

The insulated chambers have been designed especially for a study of the chilling of beef, with the view to discovering a method whereby Australian beef, as quarters, may be exported in the chilled state to Great Britain; the chambers, therefore, will be used initially almost exclusively for this purpose.

In order to maintain relatively constant temperature conditions, an insulated air lock has been provided into which the doors of the chambers open. The external walls are constructed of brick, and the partitions between each chamber of 3-in hardwood.

The insulation provided generally has been 5-in. slab cork on the ceilings, and 4-in. slab cork on the walls. As the ceiling of the sixth floor is well insulated, it has been deemed necessary to provide only 3 inches of cork on the floors of the two chambers in which it is desired to maintain strictly constant temperatures.

The cork insulation has been surfaced and rendered moisture-proof by means of ½-in. asphalt cement. An attractive appearance has been created by finishing the internal walls with several coats of cold-resistant white paint.

One chamber will be devoted entirely to the initial chilling of the hot sides of beef, and will therefore simulate conditions which will ultimately be practised in meat works exporting chilled beef. This side-chilling chamber is 7 ft. 6 in. x 11 ft. 6 in. x 11 feet average height, and, as rapid cooling of the beef is desired, it has its own refrigerating unit of the wet battery—air circulation type. The battery consists of 576 feet of 2-in. ammonia-expansion piping, over which sodium chloride brine is continually trickled. The chamber is cooled by drawing air through the battery and delivering it over a ceiling trunk-way, and returning it through trunk-ways placed at floor level; the fan used is the multi-vane centrifugal type. This chamber will accommodate fourteen sides of beef.

After the initial chilling of the beef to a temperature of 34° F. (approx.), the sides will be cut into quarters and then placed into either of two similar chambers having internal dimensions of 8 ft. 6 in. x 11 ft. 6 in. x 10 feet average height. Each chamber is cooled by the circulation of air over a dry brine-grid battery placed at the wall opposite to the door. Brine at either of two desired temperatures is supplied from refrigerated tanks placed in an adjacent small room. The method of air-circulation is similar to that employed in the side-chilling chamber. In these quarter-holding chambers, investigations will be made of the physical conditions and composition of the atmosphere which will have to be maintained in ships' holds carrying chilled beef from Australia to England, a voyage occupying about seven weeks. Accommodation is provided in each chamber for hanging fourteen quarters of beef.

The beef for experimental purposes will be brought on special trolleys from the slaughter floor, will be hoisted on to the meat rail, external to the air lock, and then run into the chambers, each being adequately provided with the necessary tracking and switches.

A unit for the study of the rapid freezing of meat is at present being erected in one of the Meat Industry Board's cold storage chambers. It will consist of a simple sodium chloride brine tank cooled by ammonia expansion pipes, and facilities for the immersion of the meat in the liquid freezing medium.

The two laboratories provided consist of a large general room for chemical and physical studies, and a small room for bacteriological work. The latter is also fitted as a dark room, wherein studies of the oxidation of fats may be carried out, since light is a potent catalyst in promoting such oxidation.

While most of the apparatus employed is similar to that in general use in chemistry and physics laboratories, for investigations on the chilling of beef, the need is apparent for extensive and accurate apparatus for the measurement of temperature, relative humidity, and rate of air flow. Of the extensive equipment of this nature, an interesting feature is the dual range, six-point chopper-bar, continuous temperature recorder. This instrument, which has an accuracy of $\pm$ 0.2° C., will partially obviate the need for continuous personal observations of the temperatures of the air, brine, and meat during the lengthy period of six to eight weeks, when a storage experiment is being conducted.

The Buffalo Fly Laboratory in North Australia.

The entomologist is not always surrounded by the amenities of life and modern science. Frequently he has to shift for himself and improvize the apparatus necessary for his work. This is especially true of the Council's buffalo-fly investigations in Northern Australia. How one great need, that of satisfactory laboratory accommodation, was met is illustrated in the photograph opposite.

The introduction of parasites from the Netherlands Indies was contemplated, and it was therefore necessary that the building should be suitable for studying these parasites under quarantine conditions.

Mr. H. Willings accordingly drew up a plan, and acted as his own foreman. The building was completed in five weeks, and, though a trifle hot in the wet season, has served well both as a quarantine insectary and as a home.

Land and facilities were made available at Burnside Station, North Australia, through the kindness of the Australian Investment Agency, and all materials except the wire gauze for the insectary cubicle were obtained locally. The total cost was under £50.

The Buffalo Fly Laboratory in North Australia.

The building consists of an outer shell 30 feet x 15 feet, built of ironwood, thatched with grass, and walled with split bamboo. The floor is made of ant-bed material. Inside, there is a central insectary cubicle 10 feet x 6 feet, walled with 60 mesh phosphor-bronze gauze. Between the insectary and one end, there is a small general laboratory fitted with bench, shelves, &c. The other end forms the living quarters of the research officer, and between the insectary and the back wall, there is good storage space for all reserve materials.

The laboratory has been used for detailed studies of the buffalo fly and other dung breeding insects, and especially for the breeding and study of the various races of the parasitic wasps, *Spalangia sundaica* and *Sp. orientalis,* which Professor Handschin introduced from the Netherlands Indies. Already, a considerable number of these wasps have been liberated locally, and Mr. T. G. Campbell is at present liberating the first consignment in North-west Queensland.

I.M.M.

Tests of the Holding Power of Nails.

(Contributed by I. Langlands, Division of Forest Products.)

In the study of the various types of wooden containers and of their relative efficiency in service, the Division of Forest Products has found that insufficient consideration is given to nailing. Although laboratory and service tests have repeatedly demonstrated that the strength of containers depends largely on the efficiency of the nailing, it is apparently not generally known that the nailing is the weak point in practically all commercial boxes and crates.

Nailed joints may fail by—(i) the nail heads pulling through the wood; (ii) the shearing of the wood from the nails; (iii) the nails breaking; or (iv) the pulling of the nails from the wood—the most common failure encountered.

The holding power of a nail depends on several factors, the most important of which are:—(*a*) the nature of the wood used; (*b*) the density of the wood used; and (*c*) the character of the nail itself. Tests have shown that the holding power of the wood increases with increase in density, and that, in general, the porous timbers (woods of the oak or ash type) have a greater holding power than the non-porous timbers (woods such as hemlock, spruce, or the pines). The characteristics of the nail which influence its holding power are the nature of the point and the character of the shank. In general, the sharper the point of the nail, the greater the holding power, provided splitting does not occur; but, on the other hand, the sharper the point, the greater the tendency of the wood to split, with consequent loss in holding power.

It is necessary to use a nail with a blunt point when working with woods which split easily in nailing. The extreme example of this type is the "dump" nail, which has no point at all. (The point of the common flat-headed nail has about the right degree of sharpness for most woods, being neither too sharp nor too blunt. If it were sharper, splitting would be likely to occur, whereas if it were blunter, its holding power would diminish.)

The second characteristic affecting the holding power of a nail is the nature of the shank. The ordinary wire nail depends for its holding power on the friction between the nail and the adjacent wood fibres. Attempts have been made throughout the world to improve the holding power by increasing the frictional resistance to withdrawal, or by substituting (at least in part) mechanical for frictional holding. The principal methods used overseas are (i) cement-coating; and (ii) barbing.

Cement-coated nails are made by tumbling ordinary nails in a drum with a resinous compound, which forms a thin coating on the nail, and increases its frictional resistance to withdrawal. This type of nail is largely used in England and America, and is probably the most popular variety having increased holding power.

As the name implies, the barbed nails have barbs cut into their shanks—the idea being that the barbs catch in the wood and resist withdrawal. However, extensive tests by the United States Forest

Products Laboratory have shown that the holding power of barbed nails driven into dry wood is less than that of plain nails, due to the fact that the barbs badly mutilate the wood fibres. On the other hand, the holding power of barbed nails driven into green timber, which has then been allowed to dry, is somewhat greater than that of plain nails treated similarly.

In Australia, several different types of special nails have been developed, all of which are claimed to have better holding power than the plain nail. The most common types are the twisted (or spiral) and the barbed (or jagged) nails. The shank of the former is twisted into a long spiral on the theory that the nail when driven will rotate like a screw, with resultant increase in holding power. The barbed nails made in Australia are rather different from those made overseas, being usually provided with notches or depressions rather than barbs, so that their behaviour is not necessarily the same as those tested by the United States Forest Products Laboratory. Cement-coated nails, although on the Australian market, have not come into favour. Other special nails produced in Australia are the chemically rusted nail and the sand-rumbled nail.

In its work in connexion with the testing of wooden containers, the Division of Forest Products was quickly confronted with the lack of knowledge on the relative merits of the various types of nails made in Australia. It was necessary, therefore, to obtain this information, and a comprehensive series of tests is being carried out to determine the relative merits of eighteen different types of local nail. The nails for these tests have been supplied by all the principal makers in the Commonwealth.

It has been decided to determine the holding power of the nails under the following conditions:—

(i) Driven into dry wood and pulled immediately.

(ii) Driven into dry wood and pulled three months after driving.

(iii) Driven into green wood and pulled immediately.

(iv) Driven into green wood and pulled after the wood has dried.

(In all tests, nails are driven into quarter and back faces, as well as end grain.)

Some nails, once they commence to yield, have very little holding power, and can be easily withdrawn. Others, even after they have started to move, still retain a firm grip on the wood, and considerable strain is necessary throughout the extent of their withdrawal. Obviously, these differences indicate important factors in the efficiency of the nails, and they also will be studied.

The results of all these tests when completed should prove of considerable interest to users of nails.

Electrical Moisture Meters for Timber.—Further Correction Figures.

The Division of Forest Products recently issued Trade Circular No. 9, describing electrical moisture meters. In these instruments, the moisture content of timber is determined by measuring indirectly the electrical resistance of the timber, but as the resistance varies somewhat from species to species at the same moisture content, small corrections are necessary when a moisture meter is used on a number of different timbers.

As an appendix to the trade circular, a table was given containing the corrections necessary for a number of common Australian and other timbers. Further tests on other species have added to this information, and the following table contains the additional correction figures. It is advised that this table should be inserted after Appendix I. in Trade Circular No. 9.

Appendix II. (Trade Circular No. 9).

Corrections Used with Blinker Sorters for Different Species of Timber.

For moisture contents in the neighbourhood of 12 to 15 per cent.

Species.		
Botanical Name.	Common Name.	
Eucalyptus albens	White box	0
Eucalyptus bicolor	Black box	0
Eucalyptus bosistoana	Gippsland box	−1
Eucalyptus consideniana	White ash	+1
Eucalyptus goniocalyx	Mountain grey gum	+2
Eucalyptus hemiphloia	Grey box	0
Eucalyptus leucoxylon	S.A. blue gum	0
Eucalyptus maculosa	White gum	−3
Eucalyptus maideni	Spotted blue gum	+2
Eucalyptus melliodora	Yellow box	+1
Eucalyptus muelleriana	Yellow stringybark	+3
Eucalyptus viminalis	Manna gum	0
Tristania conferta	Brush box	−4
Podocarpus dacrydioides	N.Z. white pine	0

Notes on the Casein-Formalin Treatment of Butter Boxes for the Prevention of Wood Taint.

(Contributed by W. J. Wiley, M.Sc.)

Experimental work on the casein-formalin treatment of butter boxes previously described in this *Journal* (Vol. 5, No. 1, 1932, pp. 5-24) has been proceeding, and the following notes are the outcome of experience gained in the treatment of a comparatively large number of experimental boxes.

The casein solution has been used at the same concentration as before. If a more concentrated solution is used, drying is, of course, quicker, but for satisfactory spraying, the solution must be warmed in order to decrease the viscosity. It has been found advantageous to increase the formalin concentration, and this is now made up by diluting 1.5 volumes of 40 per cent. formalin with 10 volumes of water.

The two solutions are sprayed on the box shook simultaneously from a double-spray gun, the sprays mixing when they hit the surface of the timber. The reaction between the casein and formalin is rapid, and in a few seconds the coating sets to a jelly which does not sink into the wood, but dries, leaving a hard varnished surface. The double-spray gun is made from two guns fitted with special nozzles. These are necessary in order that (i) the two sprays, casein and formalin solutions, differing greatly in viscosity, may be of the same size to ensure thorough mixing over the whole treated surface; and (ii) that the correct proportions of the two solutions are delivered. When using these spray guns, the formalin solution is gravity-fed, and the casein solution fed by air pressure to the guns. A pressure of 20 lb. per square inch on the casein pressure pot, and 80 lb. on the pistols for atomizing, has been found suitable with casein solution of the usual viscosity. Approximately 1.5 lb. of caesin solution and 0.2 lb. of formalin are delivered per minute. It has been found possible to kiln-dry the sprayed boards in half an hour, at a temperature of 140° F., and 20 per cent. humidity.

"Strathcona House"—A Hostel for Research Workers Visiting the Rowett Institute.

One of the features of the research work now being carried out in various parts of the Empire is the ever-increasing amount of co-ordination of effort, and its concomitant, the ready interchange of research information. It will be remembered that suggestions for the development of machinery whereby these actions might be facilitated were included in the recommendations of the 1927 Imperial Agricultural Research Conference.

That Conference considered that one of the means of rendering Empire research work effective was to arrange for exchanges of officers. The Rowett Research Institute, Aberdeen, has been very active in this way, and already one or two Australians, together with research workers from other Dominions, have been accommodated at the Institute, and have made themselves familiar with its well-known investigations in the field of animal nutrition.

A recent development at the Institute is the erection of "Strathcona House," which is a residential club or hostel for research workers attached to the Institute, or who might be visiting it. Workers from the Dominions, or visitors from the Dominions, are given the first claim to bedroom accommodation. In the past, such people necessarily had to live in lodgings. Now, however, when they go to Aberdeen they will be met and taken to "Strathcona House," introduced to all the other people staying there, and made members of the residential club.

It is believed by the Director of the Institute, Dr. Orr, and by others who have helped in this new move, that the educational value of the associations of "Strathcona House," and of the contacts made there, will be quite considerable, and will be by no means an unimportant aspect of an investigator's stay at the Rowett.

Note on an Improved Design for Electrical Resistance Thermometers for Measuring the Gradient of Temperature in Foodstuffs.

(*Contributed by N. E. Holmes, B.E.E., and J. R. Vickery, Ph. D.*)

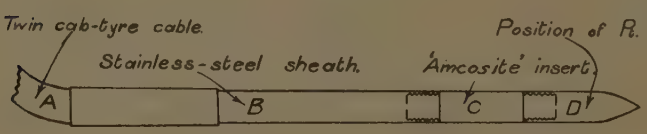
In connexion with investigations into the preservation of foodstuffs by cold, it is often necessary to determine accurately the gradient of temperature in the actual foodstuff under treatment.

In the freezing of meat, for instance, the gradient may be of the order of 3°C. per inch, and, therefore, it is necessary to employ thermometers, giving, as nearly as possible, the temperature at a point. Moreover, the gradient of temperature must frequently be measured by distant reading instruments situated outside the chamber in which the foodstuff under observation is being cooled. Electrical resistance thermometers are usually convenient instruments for such long-distance measurements. In such thermometers, the requirements are:—

(*a*) Rapid response to changes of temperature.

(*b*) Restriction to a minimum of the volume whose average temperature is to be measured.

The drawing below shows the general details of an electrical resistance spear thermometer we have designed to incorporate the above requirements, to withstand corrosion by the foodstuff, and to be sufficiently robust to withstand the strains set up when the foodstuff freezes.



Several features of the instrument have already been developed by scientific instrument makers in England. Thus, to obtain the requirement (*a*) above, the platinum resistance coil D has been confined to the small dimensions of about 0.5 inch in length and 0.15 inch diameter, the coil being cased in a thin stainless steel sheath B.

To improve the thermometer with respect to requirement (*b*) above, the "Amcosite"* insert C has been introduced. Since the thermal conductivity of steel is approximately 250 times that of "Amcosite," the use of this insert will reduce considerably the conduction of heat along the casing of the thermometer. The importance of this feature will be realized when it is stated that the difference of temperature along the stem of a thermometer thrust to the centre of a piece of meat 10 inches in thickness may be 20° to 25°C.

* "Amcosite" is a composition having characteristics similar to ebonite.

Apple Cases for the Export Trade.—Investigations Designed to Develop the Best Type.

In an article written shortly after his return from a visit to Great Britain, Mr. W. M. Carne, Senior Plant Pathologist of the Division of Plant Industry, drew attention to the little that is known about the different methods of packing Australian fruit in relation to the condition of the fruit so packed when eventually it landed on overseas' markets (see this *Journal* **5**: 40, 1932).

He also drew attention to the serious damage caused to Australian apples by bruising during transport abroad.

With a view to remedying this position some investigations have been initiated by the Council's Divisions of Plant Industry and Forest Products working in co-operation, the actual experiments being conducted at the headquarters of the Division of Forest Products in Melbourne, where the necessary facilities are available. The work, which is naturally of a seasonable nature, is being undertaken by Mr. Carne and by Mr. R. F. Turnbull, the latter an officer of the Division of Forest Products.

Attention is being given in the first instance to the two types of case in general use in the apple export trade, namely the Australian bushel (dump) case and the standard bushel case. These are being packed in different ways and with different weights of fruit. The cases are then subjected to dropping and bumping tests with the special equipment which the Division of Forest Products has for that work and the degree of bruising is noted.

By such methods it is hoped, in the first instance, to give a definite answer as to the best procedure to adopt in packing the individual boxes of apples intended for transport overseas and eventually as to how present methods, including, perhaps, box design, could be improved and standardised. In the latter connexion the Standards Association of Australia is taking considerable interest in the work, and with that end in view has set up a special committee on fruit cases.

Some preliminary work was carried out early in 1932, but its object was chiefly the development of a suitable technique for the more extensive investigations it is hoped to continue in the next apple season (early in 1933). Apart from the information regarding the best technique of testing, one or two interesting indications were obtained from the 1932 work, particularly in regard to the relative tightness of pack and its effect on bruising. It was found, for instance, that there is a definite relation between tightness of pack and the amount of bruising; further, that it is easy to pack over-tightly, and by so doing to increase the amount of damage.

The Investigation of "Peg-Leg Disease" of Cattle.—Co-operation of Queensland Producers.

In a previous note (see Vol. 5, page131) it was mentioned that, as part of the cattle investigations being carried out in co-operation with the Queensland Department of Agriculture and Stock and the Empire Marketing Board, it was proposed to study the so-called peg-leg disease

which affects cattle in certain parts of Queensland. There are indications that the trouble is caused by some deficiency, possibly phosphorus, but further studies of the condition are needed before the cause can be stated with certainty and thus the most economic means of control developed.

It was realized that it would be of considerable value from the investigational point of view if arrangements could be made to carry out some work at a small field station. As a result of active co-operation which has recently been given by certain cattle interests in Queensland, it will be possible to make much faster progress along such lines than would otherwise have been the case. The co-operation in question is outlined below.

Mr. Archie Black, of "Helenslee," near Charters Towers, has granted the use of some of his paddocks, yards, &c., besides undertaking the general management of the experimental stock, all of which has been rendered available by pastoralists of the district. In addition, through the Graziers' Association of Central and North Queensland, a number of local cattle producers and several meat exporting companies have contributed upwards of £135 towards the cost of the field station operations. Such assistance is not only appreciated from the financial point of view, but the practical evidence of keen interest in the work is a source of particular gratification.

Recent Publications of the Council.

Since the last issue of this *Journal,* the following Bulletins and Pamphlets of the Council have been, or are just about to be, published :—

Bulletin No. 65.—"Downy Mildew (Blue Mould) of Tobacco in Australia," by H. R. Angell, B.Agr.Sc., Ph.D., and A. V. Hill, B.Agr.Sc.

The results of work carried out by the Division of Plant Industry on behalf of the Australian Tobacco Investigation are recorded. The purpose of the investigations was to find out essential facts regarding the life history of the blue mould parasite and its relation to the host plant, such information to serve as a guide to further work in methods aiming at the control of the disease, which is a serious problem to the Australian tobacco industry. The causal organism is a species of *Peronspora.* It is carried over in over-wintering plants, including cultivated ornamental species of *Nicotiana.* There is some evidence, too, that it is transmissible through infected seed. As the organism appears to be strictly parasitic, there seems to be little danger of disease due to its possible persistence in the soil.

Bulletin No. 66.—"The Influence of Growth Stage and Frequency of Cutting on the Yield and Composition of a Perennial Grass—*Phalaris tuberosa,*" by A. E. V. Richardson, M.A., D.Sc., H. C. Trumble, M.Agr.Sc., and R. E. Shapter, A.A.C.I.

This is one of the reports of investigations in the field of mineral deficiencies of pastures, being carried out as the result of contributions by the Empire Marketing Board, the Waite Agricultural Research Institute, and the Council. In the work reported, the crude protein

content of the herbage fell from 33 per cent. at the early tillering stage, to 3.37 per cent. at maturity; the percentage of crude fibre and nitrogen-free extractives increased continuously from tillering to maturity; the phosphate and potash content of the dried herbage was exceedingly high in the early stages of growth, and fell steadily to a minimum value at the mature stage; when only 10.6 per cent. of the total dry matter in the herbage had been accumulated, and only 5.1 per cent. of the total water used had been transpired, the plant had nevertheless assimilated 66.2 per cent. of its total nitrogen; and a substantial and absolute loss of potash occurred from all portions of the plant during the final stage of growth, which must be regarded as a migration of potash from the plant to the soil, due possibly to diffusion from the root system at the stage when physiological activity ceases. The yield of herbage, butts, and roots, was considerably reduced by increasing the number of cuts, e.g., cutting five times reduced the yield of herbage by 54 per cent., and the root system by 78 per cent. Notwithstanding the fact that the yield of herbage was decreased considerably, with an increased number of cuts, the actual yield of protein was greatly increased; the yield of nutrients per litre of water transpired is greatly increased by increased severity of cutting.

Bulletin No. 67.—"Methods for the Identification of the Coloured Woods of the Genus *Eucalyptus*" (Division of Forest Products—Technical Paper No. 5), by H. E. Dadswell, M.Sc., and Maisie Burnell, B.Sc.

The practical importance of establishing methods of identification of Australian eucalypt timbers is constantly being brought to the notice of the Division of Forest Products. Bulletin No. 67 gives the results of work done to date, with such a development in mind. A first division has been made on the basis of colour, and the publication is confined to the coloured eucalypts (as distinct from the non-coloured). These have been studied macroscopically, microscopically, and, in some cases, chemically. A feature of the work was the care given to the selection of samples, and no studies were made on any sample unless its correct botanical classification was certain, after an examination of the botanical material from the tree from which the log was cut. The bulletin contains a number of illustrations of typical photomicrographs of the eucalypts discussed.

Bulletin No. 68.—"Radio Research Board: Report No. 5. Atmospherics in Australia—I.," by G. H. Munro, M.Sc., A.M.I.E.E., and L. G. H. Huxley, M.A., D.Phil.

The paper describes the progress of an investigation of the atmospherics which interfere with radio reception in Australia. This has been carried out by means of cathode-ray direction-finders, one located at Laverton, near Melbourne (Vic.), and the other at Mt. Stromlo, near Canberra (F.C.T.). Information is accumulating from which it will be possible to predict the interference to be expected from atmospherics on any wave-length at any place in Australia—a matter of considerable importance to radio services, particularly those concerned with broadcasting. In addition, the observations definitely indicate that atmospherics are due to lightning strokes. Further, as the instruments can easily detect the source of atmospherics 2,000 miles or more

away, their value in giving earlier information of approaching bad weather than possible with existing barometric methods of forecasting is obvious. They would be of particular value to aircraft services to give information regarding the position of local storms.

Bulletin No. 69.—"An Investigation of the Taxonomic and Agricultural Characters of the *Danthonia* Group," by A. B. Cashmore, B.Sc.

This is another publication concerning the mineral deficiency investigations mentioned in Bulletin No. 66 above. The literature on the value of the *Danthonia* species (wallaby grasses) for grassland work is brought together and discussed. It is stated that the species are low fertility demanders, and that they are able to adjust themselves to extremes of rainfall and temperature conditions. When mature, the feed tends to be coarse and fibrous, and somewhat unpalatable to stock, but if maintained at an immature stage of growth by rotational grazing, good yields of highly nutritious fodder may be expected at low water cost. The work carried out shows the possibility of obtaining further strains for use in the drier areas of Australia where introduced species of pasture plants are unable to persist. The extended production period of *Danthonia* and its capacity to produce green feed after rain in hot summers are stressed. These qualities are of particular value where wool production is the aim.

Bulletin No. 70.—"A Soil Survey of King Island," by C. G. Stephens, M.Sc., and J. S. Hosking, B.Sc.

The soil survey of King Island, which is reported in this Bulletin, was undertaken at the request of the Tasmanian Department of Agriculture, in order to provide a basis for the advisory and experimental work of its veterinary and agricultural officers. The stock problems of King Island have acquired something more than mere local interest, owing to the development of "coastiness," a disease of stock, akin to the "bush sickness" of New Zealand, which is quite definitely associated with the calcareous sandhills of the west coast, and which, like other cases of "coastiness" in Australia, can be cured by transferring the stock to other areas. Eight soil types have been identified and named. The coastal disease is particularly associated with the type to which name "Currie calcareous sand" has been given.

Pamphlet No. 31.—"A Preliminary Report on Investigations on the Buffalo Fly (*Lyperosia exigua* de Meij) and Its Parasites in Java and Northern Australia," by Professor E. Handschin.

The pamphlet consists of a preliminary report, recording the results of two years' investigations by Professor Handschin, of the University of Basle, who was brought out by the Council for the purpose. The report gives a number of details concerning the life history of the buffalo fly, and of its reactions to different stimuli and environments. An account is also given of experiments in cross breeding an Australian variety of *Spalangia* (*S. orientalis*) with a Javan variety (*S. sundaica*), both of which varieties parasitize the puparia of the buffalo flies, and thus eventually destroy them. In addition, the various habits of these species of *Spalangia* have been studied. It has been found, for instance, that females are attracted to dung still moist and containing

buffalo-fly puparia, while males are attracted to dry dung in which females are emerging. This last ensures the meeting of the sexes at the time that buffalo-fly puparia are forming in the dung. Genetical experiments with the Australian-Javan cross of *Spalangia* show that females of the Australian variety, crossed with males of the Javan variety, live twice as long as normally, and lay three times as many eggs. The reverse cross is ineffective. At the present time, an effective cross that has been bred up is being liberated in North Australia with a view to observing its effect.

Pamphlet No. 32.—"The Chemistry of Australian Timbers, Part 2—The Chemical Composition of the Woods of the Ironbark Group" (Division of Forests Products—Technical Paper No. 4), by W. E. Cohen, B.Sc., A. L. Baldock, B.Sc., and A. G. Charles.

There is a general trend in forest products research towards utilizing wood substances after some form of chemical transformation. Other investigations involve altering the physical characteristics of wood, to increase its resistance to fire, and to reduce in seasoned timber the absorption of and loss of moisture, with consequent swelling and shrinkage. Such proposals, and those associated with converting wood into paper, artificial silk, lacquers, &c., must have their foundation in a fuller knowledge of the chemistry of timber. For this reason, *inter alia,* the Division of Forests Products is carrying out some work in the chemical field. The work reported in the pamphlet shows that the Ironbark eucalypts differ in chemical composition from the hardwoods of North America, and that an outstanding feature in the Australian timbers is the presence of large quantities of gum-like substances, which are found in the various wood cells, and which are insoluble in the organic and neutral solvents usually employed in wood analysis. Numerous regular differences in certain chemical factors such as alkalinity of ash, cellulose content, and percentages of "solubles" in various solvents, were found, and the possibility of employing these as an aid to timber identification is indicated. Another result of the work is valuable information regarding the degree of fineness to which it is necessary to grind timber samples, in order that resultant analyses may be a correct reflex of the composition of the original timber.

Pamphlet No. 33.—"Enzootic Haematuria (Haematuria Vesicalis) of Cattle in South Australia," by L. B. Bull, D.V.Sc., C. G. Dickinson, B.V.Sc., and A. T. Dann, M.Sc.

Haematuria vesicalis or "redwater" of cattle is described as it occurs in a certain restricted area of South Australia. Attention has been given to the geological nature of the country, to urine analyses, to the soils, and to the pastures. Urine analyses have so far failed to reveal the presence of an irritant, which might be calculated to cause the lesions in the bladder. Certain differences in the proportion of the urinary constituents, from those found in normal cows' urine, have been demonstrated, but no etiological significance can be attached to these findings at the present time. No attempt is made to discuss the distribution of the disease throughout the Commonwealth, but attention is drawn to its occurrence elsewhere, notably in Victoria and Tasmania, as well as to its former appearance in New Zealand. There is also evidence that it occurs in at least one restricted area in southern Queensland.

Pamphlet No. 34.—"The Collembola-Symphypleona of Australia: A Preliminary Account," by H. Womersley, A.L.S., F.E.S.

The pamphlet contains a report, dealing with the systematics of the group of insects containing the lucerne flea (globular springtail) which is causing such damage to pastures in various parts of Australia. It contains a foreword by Dr. R. J. Tillyard, M.A., F.R.S., in which the economic value of the work is discussed, and in which it is pointed out that a study of the systematics of the group is an essential preliminary to any comprehensive investigation of the possible control of the individual members of the group. It is also mentioned that a predatory mite of the genus *Biscirus* is an effective biological agency controlling the lucerne flea in a few restricted areas of Western Australia.

Pamphlet No. 35.—"'Pulpy Kidney' in Lambs." (1) "'Pulpy Kidney,' or Acute Infectious Entero-toxaemia of Sucking Lambs due to *B. ovitoxicus* (Bennetts)," by D. T. Oxer, B.V.Sc. (2) "'Pulpy Kidney'—A Post-mortem Change in Experimental Infectious Entero-toxaemia," by H. W. Bennetts, D.V.Sc.

This publication consists of two reports of work carried out as a part of the Australian Pastoral Research Trust-Empire Marketing Board scheme, and in co-operation with the Departments of Agriculture of Tasmania and Western Australia. It has resulted in the important demonstration that "pulpy kidney" of lambs, which often causes serious losses to producers of fat lambs in Tasmania and the Eastern States, is due to the same organism, namely, *Bacillus ovitoxicus,* that causes the so-called braxy-like disease of sheep in Western Australia. The development of an economic method of control is thus correspondingly nearer.

Forthcoming Publications of the Council.

At the present time, the following future publications of the Council are in the press:—

Bulletin No. 71.—"Investigations on Irrigated Pastures." 1. "The Yield and Botanical Composition of an Irrigated Permanent Pasture under Various Systems of Pasture Management," by A. E. V. Richardson, M.A., D.Sc., 2. "The Chemical Composition of Irrigated Pastures at Wood's Point, South Australia," by H. P. C. Gallus, B.Sc.

Bulletin No. (?).—"A Soil Survey of the Nyah, Tresco, Tresco West, Kangaroo Lake (Vic.), and Goodnight (N.S.W.) Settlements," by J. K. Taylor, B.A., M.Sc., F. Penman, M.Sc., T. J. Marshall, B.Sc. (Agr.), and G. W. Leeper, M.Sc.

Pamphlet No. 36.—"Fibre Boards—Their Use, and the Possibilities of Their Manufacture in Australia," by R. F. Turnbull, B.E.

Pamphlet No. (?).—"The Blowfly Problem in Australia, edited by R. J. Tillyard, D.Sc., F.R.S., and H. R. Seddon, D.V.Sc.